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CONSPECTUS GENERIS AMORPHAE

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In reviewing the genus Amorpha for my *Illustriertes Handbuch der Laubholzkunde*, I had the opportunity of looking over the forms of this small but variable genus, for Professor TRELEASE had kindly sent me the rich collection of the Herbarium of the Missouri Botanical Garden. I am very much indebted to him for his great assistance to me in all my dendrological studies.

In SMALL'S *Flora S. E. United States*, F. E. BOYNTON has published a good synopsis of most of the species of the genus, but there seem to me to be some errors of statement arising from a failure to clear up some of the descriptions of the older European and American authors. I take this opportunity, therefore, to refer to some points concerning which I think BOYNTON has taken a wrong view.

CLAVIS ANALYTICA SPECIERUM

1a. Foliola infima proxime super basin subdilatatam petiola adnata ramo valde approximata fere pseudostipulosa. 2.

1b. Foliola infima distincte paulo superius rhachi adnata a ramo plus minusve distantia. 3.

2a. Calycis dentes omnes fere aequilongi, tubo paullo breviores; foliola 15–51, subsessilia, ovato-oblonga vel oblongo-elliptica, basi rotunda, apice fere semper subacuta, valde approximata; planta omnibus partibus albo-canescens
2. *A. canescens*

2b. Calycis dentes diversi, superiores breviores et paullo obtusiores (sed satis variabiles); foliola distinctius petiolulata, elliptica vel anguste-elliptica, basi semper apice plerumque rotunda; planta haud distincte denseque canescens sed plus minus pubescens; interdum subglabrescens . . . . 1. *A. herbacea*

3a. Folia minus quam 10^{cm} longa; foliola 15–35, brevepetiolulata, anguste-elliptica vel elliptica, utrinque rotunda vel subrotunda, 6–13^{mm} longa et 2.5–7^{mm}

lata; calycis dentes omnia subacuminata, superiores paullo breviores, inferiores tubo fere subaequilongi; petala obovata, apice leviter emarginata, basi in unguem brevissimum contracta; fructus dorso fere recti nec non recurvati 4–5^{mm} longi, glanduloso-verrucosi; planta adulta omnibus partibus glabriuscula . . . . . 3. *A. microphylla*

3b. Folia longiora; foliola majora vel planta ceteris signis diversa. 4.

4a. Foliorum rhaches ramulique juniores glanduloso-hispiduli (*i. e.* glandulis pedicellatis aculeiformibus sparsis obtecti); calycis dentes subacuminati, subaequilongi, tubo fere paullo longiores . . . . . 5. *A. hispidula*

4b. Glandulae pedicellatae semper deficientes. 5.

5a. Foliola pro genere permagna, vix minus quam 3.5–4^{cm} longa, pagina inferiora nervis lateralibus distincte elevatis, canescentia, subcoriacea; planta ramis junioribus rhachibusque foliorum et inflorescentiarum dense tomentosa 14. *A. paniculata*

5b. Nervi laterales foliorum subtus non vel vix elevati vel planta partibus indicatis haud tomentosa. 6.

6a. Calycis dentes brevissimi et obtusissimi, multo latiores quam longi; petala fere orbicularia, basi brevissime unguiculata; folia ad 20^{cm} longa; foliola 9–19, ovata, ovato-elliptica vel late elliptica, basi rotunda vel subrotunda, apice obtusa vel leviter emarginata, terminalis ad 6×3^{cm} magna; fructus dorso recti, 7–8^{mm} longi, sparse glanduloso-verrucosi; planta fere omnibus partibus glaberrima . . . . . 7. *A. glabra*

6b. Calycis dentes semper distincti, acuti vel planta ceteris signis diversa. 7.

7a. Calycis dentes omnes fere aequilongi distincte acuminati, tubo sublongiores; folia 10–15^{cm} longa; foliola 13–21, valde approximata, marginibus se integentia, ovato-elliptica vel elliptica, basi rotunda, apice rotundata vel obtusa, vix emarginata, mucrone brevi instructa, 2.5–3.6^{cm} longa et 1.2–1.7^{cm} lata, brevi-petiolulata, nervis lateralibus subtus subelevatis; fructus (an maturi?) dorso, ut videtur, recti, 0.5^{mm} longi, glanduloso-verrucosi; planta omnibus partibus subtomentella . . . . . 4. *A. Schwerini*

7b. Calycis dentes diversi, superiores breviores et nondum acuminati vel foliola semper conspicue remota, marginibus inter se non contingentia. 8.

8a. Folia 7–16^{cm} longa; foliola 10–33, elliptica vel anguste-elliptica, utrinque rotundata, pleraque levissime emarginata, mucronulata, breve sed distincte petiolulata, 7×5^{mm} ad 17×7^{mm} vel 15×5^{mm} magna, fere subcoriacea; dentes calycis superiores subacuti, inferiores subacuminati longiores; fructus dorso recti, 0.5^{mm} longi, glanduloso-verrucosi; planta omnibus partibus glabriuscula sed inflorescentiis distinctius pubescentibus . . . . . 8. *A. caroliniana*

8b. Foliola majora vel planta ceteris signis diversa. 9.

9a. Foliola satis magna, vix minus quam 1.5^{cm} lata, basi rotunda vel cordata, subcoriacea; fructus dorso fere recti vel ad apicem subito leviter recurvati. 10.

9b. Foliola distincte angustiora vel basi subacuta vel tenuiora membranacea vel fructus dorso manifeste recurvata (falcata!). 11.

10a. Foliola superne nitentia, plus minus duplo longiora quam lata, 2.2–4×

1.4–2^{cm} vel ad 6×2.5^{cm} magna; petala obovato-cordata, brevi-unguiculata, 6–7^{mm} longa; fructus maturi 7–9^{mm} longi; dorso ad apicem subito leviter recurvati, dense vel vix glanduloso-verrucosi . . . 12. *A. virgata* (et *A. nitens*)

10b. Foliolo superne haud nitentia, minus quam duplo longiora quam lata, 0.5×1.2 vel 2×1.5 ad 5×4 vel 5.5×3.5^{cm} magna; petala basi in unguem distinctum contracta; fructus dorso recti, 7^{mm} longi, glanduloso-verrucosi; planta omnibus partibus pubescentia vel glabriuscula

13. *A. laevigata* (et *A. texana*)

11a. Folia 9–20^{cm} longa; foliola 11–17, ovato-elliptica vel elliptica, basi late subacuta, raro manifeste rotundata, apice obtusa vel rotunda vel subacuta, 2.3–4×1.2–2.2^{cm} magna; petiolula ad 3^{mm} longa; petala obovato-oblonga, 0.5^{mm} longa; fructus 0.6^{mm} longi, vix (an semper?) glanduloso-verrucosi; planta adulta glabriuscula . . . . . 6. *A. californica*

11b. Planta foliis vel fructibus vel signis ceteris diversa. 12.

12a. Fructus dorso fere recti plus minus distincte, 6^{mm} longi, glanduloso-verrucosi; folia 8–15^{cm} longa, foliola 12–31, anguste elliptica vel anguste ovato-lanceolata, utrinque rotundata, apice mucronulata, 12–18×6–8^{mm} magna, brevi-petiolulata; dentes calycis breves, superiores fere rotundi, inferiores acuti medio paullo longiore; petala obovata, brevi-unguiculata, 0.5^{mm} longa; planta omnibus partibus junioribus molliter pubescens, deinde glabriuscula

9. *A. tennessensis* (cf. etiam 10)

12b. Fructus manifeste falcata (dorso recurvata), fere semper longiora vel foliola latiora vel utrinque acuta. 13.

13a. Folia 9–20^{cm} longa; foliola 15–27, lanceolata, utrinque (praecipue basi) acuta vel apice subrotundata, mucronulata, 2–3.2×0.7–0.8 vel rarius ad 3×1.2–1.5^{cm} magna, distincte petiolulata; fructus maturi 6–7.5^{mm} longi; planta adulta satis glabriuscula, sed folia non glabra

10. *A. angustifolia* (cf. etiam 9)

13b. Folia ad 30^{cm} longa; foliola 11–25, plerumque majora, forma variabilis; fructus maturi 8–9^{mm} longi; planta pubescens vel adulta plerumque glabriuscula . . . . . 11. *A. fructicosa*

In the following pages I shall comment upon each species and its forms and shall attempt to clear up its synonomy. It also seems best to cite all the specimens I have seen. Figures of most of the details of leaves, calyx, petals, and fruits will be found in my *Illustriertes Handbuch* **2**: pt. 1. 1907.

1. A. HERBACEA Walt. Fl. Carol. 179. 1788.—*A pubescens* Willd. Berlin. Baumzucht 17. 1796; *A. pumila* Michx. Fl. Bor.-Am. **2**:64. 1803.

Var. *α*. TYPICA.—Foliis majoribus, ad 25^{cm} longis; foliolis 15–37–35, ad 2.5×1.3^{cm} magnis.

NORTH CAROLINA.—Bladen Co., *Biltm. Herb.* no. 35, 9. ix. 96 and no. 35b, 20. vi. 97; Buncombe Co., *Biltm. Herb.* no. 35a, 9. vii. 98.

SOUTH CAROLINA.—Aiken Co., *H. Eggert*, 24. iii. 99.

GEORGIA.—Richmond Co., *H. Eggert*, 22. v. 99.

FLORIDA.—Sumter Co., *Curtiss*, no. 5414; *Tracy*, no. 6831 (locality unreadable).

Var. β. **Boyntoni**, var. nov.—Differt: foliis minoribus, ad 18^{cm} longis; foliolis valde approximatis, 33–70, tantum ad 18×6–7^{mm} magnis.

GEORGIA.—Bulloch Co., *R. M. Harper*, no. 942.

FLORIDA.—Lake Co., *Hitchcock*, in the vicinity of Eustis, vi–vii. 94; *G. V. Nash*, no. 1147; Pasco Co., *Curtiss*, no. 6664; Hernando Co., *Hitchcock*, vi–vii. 98; ad fl. St. John's *Rugel*, no. 166; ad ripas fl. Manatee, *Rugel*, no. 165.

A very graceful variety, with its numerous small leaflets, but apparently connected with the type by some intermediate forms, so that I do not venture to treat it as a species.

2. A. CANESCENS Nutt., Fraser Cat. 1813.

Var. α. TYPICA.—Foliolis apice plus minus distincte acuta vel subacuta, etiam adulta subtus cinereocani; inflorescentiis plerumque 12–15^{cm} longis.—Vidi specimina numerosissima ex regionibus subtus indicatis.

Saskatchewan, Dakota, Minnesota, Wisconsin, Nebraska, Iowa, Illinois, Missouri, Arkansas, Indian Territory, Texas (*Lindheimer*, vii. 42, dry prairies, Lynchburg), New Mexico (*Earle*, no. 205 ex parte, El Capitan Mts.; *Brandegee*, no. 12023, San Miquel Co.).

Var. β. GLABRATA Gray, Pl. Wright. 1:49. 1852. emend. (incl. var. *leptostachya* Engelm. apud Torr. and Gray, Pl. Fendl. 31. 1849. nom. nud. [sec. specim. orig.!]).—Differt: foliolis obtusioribus, utrimque fere aequaliter rotundatis, supra glabrescentia, subtus glabriuscula, viridescentia; inflorescentiis plerisque longioribus (ad 30^{cm}).

NEW MEXICO.—San Miquel Co., *Fendler*, no. 125.

MISSOURI.—Franklin Co., *Herb. Fritchey*, 16. vi. 86; *Bush*, no. 735. Ewan (?); *Dewart*, no. 69, Springfield.

This form is apparently connected with the type by the following specimens; *Earle*, no. 205 ex parte (New Mexico); *Lüders*, 1842, Franklin Co., Missouri; *Mead*, 1843, Augusta, Illinois.

A glabrescent form with very acute leaflets was collected by *Lapham*, 1843, Milwaukee, Wisconsin.

There is another remarkable form of the type with very large and obtuse leaflets (ad 2×1.3^{cm} magnis) of the lower leaves, from Watson, Missouri, *Bush*, no. 217.

3. A. MICROPHYLLA Pursh, Fl. Am. Sept. **2**:466. 1814.—*A. nana* Nutt. Gen. N. Am. Pl. **2**:91. 1818; nec Nutt. 1813 (*fide* Torr. et Gray, Fl. N. Am. **1**:690. 1840) non Sims 1820.

Vidi specimina numerosa ex Manitoba, Dakota, Minnesota, Iowa, Nebraska, et New Mexico (*Gordon*, no. 13, iv. 48, Upper Canadian River).

4. **A. Schwerini,** sp. nov.

NORTH CAROLINA.—Rowan Co., *J. K. Small*, 18–27. viii. 94, on Dunn's Mt. (fructibus semi-maturis).

With its very long acuminate calyx teeth, and its very approximate, rather large leaflets pubescent on both sides, this form seems to be a good but very local species.

5. A. HISPIDULA Greene, Fl. Francisc. **1**:14. 1891.—*A. californica* Hook. et Arn. Bot. Beech. Voy. 333. 1841, nec Nuttall apud Torr. et Gray.

CALIFORNIA.—Shasta Co., *H. E. Brown*, no. 232½, 15–18. v. 97; Ventura Co., *Elmer*, no. 3950; Monterey Co., *Elmer*, no. 3280; Sonoma Co., *Heller*, no. 5757; Los Angeles Co., *LeRoy Abrams*, no. 2622; *H. E. Hasse*, v. 92; Orange Co., *LeRoy Abrams*, no. 1828; San Bernardino Co., *G. Engelmann*, 21. ix. 80; *Parry* et *Lemmon*, no. 10811 (no. 97); *Parish*, nos. 3198 et 4185; *H. M. Hall*, no. 1288.

A very distinct species with its prickle-like glands. HOOKER and ARNOTT say (*l. c.*) "ramulis petiolisque glandulis rigidis acutis *aculeatis;*" while NUTTALL (apud Torr. et Gray) makes no mention of such glands and plainly says "teeth of the villous calyx all acute and *short;*" but it is somewhat strange that he also says "petioles furnished with *minute glandular* scales." Unfortunately I had no opportunity to see an original specimen of Nuttall from Santa Barbara, where *A. hispidula* seems to occur very frequently.

6. A. CALIFORNICA Nutt. apud Torr. et Gray, Fl. N. Am. **1**:306. 1838.

CALIFORNIA (southern).—San Francisco Mts., *Hall*, no. 2121; San Diego Co., *Orcutt*, near Jacumba valley, vi. 90; *LeRoy Abrams*, no. 3425; *Cleveland*, no. 1361, in 1874.

ARIZONA.—Santa Rita Mts., *Pringle*, 5. vi. 84; *Engelmann*, 27. ix. 80 (in the leaflets this specimen very much resembles *A. angustifolia*, but the rather glandless small fruits are quite the same as those of the Mexican plant); Fort Whipple, *E. Palmer*, no. 240.

NEW MEXICO.—Grant Co., *Metcalfe*, no. 133; Albuquerque, *Harward*, no. 12; Doña Ana Co., *Wooton*, no. 46.

MEXICO.—Chihuahua, *Pringle*, no. 1588 (Paso del Norte).

This species seems very nearly allied to *A. fruticosa* (and also to *A. angustifolia!*), but the fruits are smaller and only a little falcate. Unfortunately I saw only very few mature fruits, and I believe that the following forms may belong to *A. californica* rather than to *A. frutiosa;* some of them probably represent *A. laevigata* Boynton, but I never found a standard broader than long. For further comments see under *A. laevigata.*

TEXAS.—Lynchburg, *Lindheimer,* vii. 42; Comale Creek, *Lindheimer,* no. 335, vi. 45; without locality, *Lindheimer,* no. 38, in 1843; Gillespie Co., *Jermy;* Comanche Co., *Eggert,* 8. v. 00; Dallas Co., *Eggert,* 23. vi. 99 (the plant of 24. vi seems to be *A. angustifolia!*).

And with (?) the following:

ARKANSAS.—Fayetteville, *Harvey,* no. 19.

COLORADO.—Fort Collins, *Crandall,* 12. vi. 96; Denver, *Bisson,* no. 13a; Military Park, *E. C. Smith,* 26. vi. 91.

7. A. GLABRA Poiret, in Lam. Encycl. Suppl. **1**:330. 1810, nec Boynton.—?*A. glabra* Desf. Cat. Hort. Paris 192. 1804 (*nomen nudum*) et Persoon, Syn. **2**:295. 1807 (*nomen nudum*); *A. montana* Boynton, Biltm. Bot. Stud. **1**:138. 1902.

NORTH CAROLINA (western).—Rutherford Co., *Rugel,* v. 41, in montibus ad Broad River; *Biltm. Herb.,* no. 14f, 10. v. 98; Polk Co., *Biltm. Herb.,* no. 14d, 31. v. 97; Biltmore, *Biltm. Herb.,* no. 14, 13. v et 29. viii. 96 et no. 14b, 2. vi. et 20. ix. 97.

TENNESSEE (eastern).—Knoxville, *A. Ruth.* no. 304.

POIRET (*l. c.*) gives a very clear description in French and the following short but satisfactory diagnosis in Latin: "Amorpha glabra, foliolis pedicellatis, obtusis; dentibus calycinis omnibus obtusis, brevissimis." BOYNTON and all other authors seem to have completely overlooked POIRET's description. *A. glabra* also seems to be a very local species, like *A. Schwerini.*

8. A. CAROLINIANA Croom, Am. Jour. Sci. **25**:74. 1834 (confer etiam apud Torr. et Gray, Fl. N. Am. **1**:305. 1838).—*A. cyanostachya* Curtis, Jour. Boston Soc. Nat. Hist. **1**:140. 1835 (1837), vidi specim. orig.; *A. glabra* Boynton, in Small Fl. S. E. United States 626. 1903.

NORTH CAROLINA (eastern).—Newborn, *Loomis* (*fide* Croom; spec. orig. non vidi!); Wilmington, *Curtiss* (vidi!)

GEORGIA.—Johnson Co., *R. M. Harper,* no. 1347; very similar also Lloyd Co., *Chapman Herb.,* no. 1322 (or 1522).

FLORIDA.—*Biltm. Herb.,* no. 5767; *Herb. Chapman* (this specimen has been named by BOYNTON *A. glabra* Desf.); there are also in Herb. Mo. Bot. Garden two sheets of *Herb. Chapman* no. 1524 without any other indication.

TEXAS.—Very similar are some small specimens from Columbia, *Bush*, nos. 962 and 1581.

A. caroliniana, as I understand it, is a very glabrous species, with leaflets relatively shorter and broader than those of *A. tennessensis* and *A. angustifolia;* but without very ripe fruits it is often difficult to say to what species such a form may belong. Only specimens collected in September have the fruits fully ripened.

9. A. TENNESSENSIS Shuttlw. in Kunze Delect. Sem. Hort. Lips. p. 1. adn. 1848, et in Linnaea **24**:191. 1851 (descript. non sufficiens); vide Boynton in Small Fl. S. E. United States 625. 1903.

TENNESSEE.—Prope Dandridge, *Rugel*, vi et ix. 42 (specim. orig., fructibus maturis dorso fere rectis!); Polk Co., *Biltm. Herb.*, no. 1381a.

It is not without some reservation that the following specimens are placed with this species:

NORTH CAROLINA.—Stanley Co., *Small*, 18. viii. 92.

FLORIDA.—John's Pass, *Tracy*, no. 7794.

ALABAMA.—Colliert Co., *Eggert*, 21. v. 99, Tennessee River near South Florence (foliis infimis cum foliolis ad 3×1.5^{cm} magnis!).

LOUISIANA.—Port Eads, *Tracy* et *Lloyd*, no. 176.

ARKANSAS.—Bertig, *Trelease*, 28. x. 97; Beaver Sta., *Glatfelter*, 18. vii. 98; *Herb. Engelmann*, no. 298, July 1835.

MISSOURI.—Jasper Co., *Trelease*, nos. 195 et 201. (in 1897).

ILLINOIS (southern).—Elsah, *Reed*, vi. 98. (an *A. fruticosa* var. *humilis* [Tausch] m. ?).

10. A. ANGUSTIFOLIA Boynton, Biltm. Bot. Stud. **1**:139. 1902.—*A. fruticosa* var. *subglabra* Gray, Jour. Bost. Soc. Nat. Hist. **6**:174. 1850.

A somewhat doubtful species, apparently connected with *A. fruticosa* (and probably also with *A californica*) by intermediate forms. BOYNTON cites as synonym *A. fruticosa* var. *angustifolia* Pursh, Fl. Am.-Sept. **2**:466. 1814, but I think it is very difficult to decide what form PURSH named var. *angustifolia* without having at hand his original specimens. He gives no other locality of his *A. fruticosa* than "Carolina and Florida." Concerning his *A. angustifolia* he remarks, "v. s. in Herb. Lewis." Probably the var. *angustifolia* of Pursh is the same as *A. humilis* Tausch, which is only a small form of typical *A. fruticosa*. The typical *A. angustifolia* according to BOYNTON has elliptic to linear-oblong leaflets which are distinctly acute at both ends. The fruits are as falcate as in *A. fruticosa*. In habit it very much resembles *A. tennessensis*, but that species has more numerous and more approximate leaflets, which are rounded or obtuse at each end. The following specimens seem to me typical *A. angustifolia:*

TEXAS.—New Braunfels, *Lindheimer*, no. 595; Kerr Co., *Heller*, no. 1596; Dallas Co., *Eggert*, 24. vi. 99 (cf. etiam sub *A. californica*); Mitchell Co., *Eggert*, 8. vi. 00.

INDIAN TERRITORY.—Sapulpa, *Bush*, nos. 70 et 1105.

NEW MEXICO.—Pawnee Fork, *Fendler*, no. 126.

KANSAS.—Manhattan, *Norton*, 9. viii. 92, and also Riley Co., no. 89 (and also no. 89a ?).

IOWA.—Steamboat Rock, *Pammel*, *Hume*, and *Fitz*, no. 1621.

The following specimens seem to be somewhat intermediate between *A angustifolia* and *A. fruticosa* (especially its var. *humilis*, which can be determined clearly only from living specimens!).

MISSOURI.—Taney Co., Forsyth, *Wm. Trelease*, 7. viii. 97.

COLORADO.—Beaver Co., *Redfield*, no. 71 (vel 1365).

SOUTH DAKOTA.—Lake Campbell, *Herb. Luke*, 13. vi. 91.

WYOMING.—Laramie Co., *Nelson*, no. 8657 (forma foliolorum valde variabilis!).

11. A. FRUTICOSA L., Sp. Pl. **2**:713. 1753.—*A. perforata* Schkuhr, Bot. Handb. **2**:333. 1808; *A. elata* Hayne, Dendrol. Fl. 134. 1822; *A. pubescens* Schlecht. Linnaea **34**:691. 1851.

The type of this species is very clearly indicated by Linnaeus in citing "Hort Cliff. p. 353. *tab.* 19," but I have seen only a relatively small number of specimens which represent this type. It was collected first by *Catesby* in North Carolina. I distinguish the following varieties, but I believe that such widely distributed forms as *A. angustifolia* and *A. tennessensis* can only be taken for varieties of *A. fruticosa*. Probably also *A. californica* and *A. caroliniana* may be considered as mere geographical varieties of *A. fruticosa*.

Var. TYPICA.—Frutex elata partibus omnibus junioribus sericeo-pubescentibus adultis glabriusculis vel glabris.

NORTH CAROLINA.—Stanley Co., *Small* et *Heller*, no. 380 (a form somewhat intermediate between typical *A. fruticosa* and *A. tennessensis*); loco non indicato, *S. B. Buckley*.

ILLINOIS.—Stark Co., *V. H. Chase*, no. 737; Washington Co., *French*, no. 1362 (forma pube var. *crocealanata* simili).

IOWA.—Ames, *Ball* et *Meeker*, no. 525, et *Hitchcock;* Story City, *Pammel* et *Ball*, no. 1753 (?), 4. vi. 98; Decatur Co., *Anderson*, 9. vi. 01.

MISSOURI.—Jefferson Co., *Eggert*, 5. v. 96; *Dr. O. Krause*, 23. v. 66; St. Louis Co., *Eggert*, 6. v. 75; Webb City, *Bush*, no. 553; Bridgeton, 28. v. 59; Jackson Co., *Bush*, 13. vi. 92.

NEBRASKA.—Saye Creek, *Hayden*, 22. vi. 53; Kearney, *Pammel* et *Brownlee* (?), 27. vi. 99.

KANSAS.—Cowley Co., *Madwhite* (?), iv. 98.

OKLAHOMA.—Stillwater *Waugh*, no. 353 (an var. *humilis*?).

The following forms are doubtful:

WYOMING.—Fairbanks, *A. Nelson*, no. 337.

ARKANSAS.—Fulton, *Bush*, no. 2451.

ALABAMA.—Monte Sano, *Baker*, 23. v. 97 (glaberrima, foliis iis *A. glabrae* simillimis, sed calycis dentes ut in *A. fruticosa*).

FLORIDA (east).—Indian River, *Palmer*, no. 104 (et 1364) (foliolis ad 39!).

Var. **humilis,** var. nov.—*A. humilis* Tausch, Flora **21**:750. 1838; the following names are also probably synonyms: *A. nonperforata*—Schkuhr, Bot. Handb. **2**:333. 1808; *A. nana* Nutt. Fraser Ctal. 1813, fide Torr. et Gray, et *A. nana* Sims, Bot. Mag. *tab. 2112*. 1820, haud Nutt. 1818; *A. fruticosa* Hayne, Dendrol. Flora 134. 1822, nec Linn.—Frutex humilis, foliis plerisque paullo minoribus saepe angustioribus iis *A. angustifoliae* haud dissimilibus.

As I said above, it is very difficult to decide whether a dried specimen belongs to typical *A. fruticosa* or to this variety or even to *A. angustifolia*, but the original specimens of TAUSCH are certainly not identical with *A. angustifolia*. The latter I never found living in our European gardens. Likewise the dwarf *humilis* everywhere appears within the limits of the type and perhaps only represents a mere "Standortsform."

Var. **crocealanata,** var. nov.—*A. crocealanata* Watson, Dendrol. Britann. **2**: *tab. 139*. 1825; an *A. pumila* Tausch, Dendroth. Bohem. exsicc., nec Michx. ?—Frutex elata omnibus partibus junioribus satis dense flavocanescentibus fere hirsutulis, foliolis etiam adultis superne sparsius subtus densim pubescentibus.

WATSON gives a very good description and drawing of his species, and the following forms agree very well with his characters:

MISSOURI.—Ocean Springs, *Miss Skeban* (?) 8. v. 95.

LOUISIANA.—Alexandria, *C. R. Ball*, no. 422.

ALABAMA.—Mobile, 16. iv (this specimen in the leaves somewhat resembles *A. herbacea*, but the calyx is quite that of *A. fruticosa*).

FLORIDA.—*Herb. Chapm.*, without other indication (this form has the leaflets in part somewhat more broadly elliptical); loco non indicato, *Herb. Chapm.* no. 1345.

Unfortunately all these specimens are in flower or with only very young fruits. It seems to me of great interest that such analagous forms appear in such very different localities.

12. A. VIRGATA Small, Bull. Torr. Bot. Club **21**:17. 1894.—A *georgiana* Small, Mss. in Herb.

GEORGIA.—DeKalb Co., Stone Mt., *Small*, 3 et 17. vii. 93; *Biltm. Herb.* no. 14c, 12. v. et 8. ix. 97; *Eggert*, 17. v. 99 (one of these forms with very large leaflets, 6.5×3.5^{cm}, seems to me very near to *A. nitens* Boynt.) and 22. vii. 97; Cobb Co., *Harper*, no. 226.

NORTH CAROLINA.—Without locality or number, *Ashe* (distributed as *A. georgiana* Small).

FLORIDA.—Lake Co., Eustis, *Hitchcock*, vii. 94; *Nash*, no. 261 (see also the undetermined forms).

A. virgata typica is a species with rather broad ovate or elliptic-ovate leaflets; but there are the following southern forms (from Florida) which differ in smaller, more elliptic-lanceolate leaflets with more cuneate base. I cannot say yet whether they represent a good variety.

GEORGIA.—Gwinnett Co., *Small*, 20. vii. 93.

FLORIDA.—Near Jacksonville, *Curtiss*, no. 6410; Volusia Co., *Curtiss*, no. 6684; Clearwater, *Tracy*, no. 6870; Lemon City, *Tracy*, no. 7726; Lee Co., *Hitchcock*, no. 52.

In Biltm. Bot. Stud. 1:139. 1902, BOYNTON describes as a new species *A. nitens* from Waynesboro, Georgia. Unfortunately I have no type specimen at hand. It is possible that *A. nitens* is a good but very local species, distinguished by its glossy twigs, its thinner leaflets, and its more falcate nearly glandless legumes; but all these characters are rather slight ones.

I have before me two different specimens which I cannot identify with any other form mentioned here; the first probably may belong to *A. nitens;* the second is a very striking form, most resembling *A. paniculata* (nervis foliolorum subtus elevatis), but the leaflets are rather thin and glabrescent.

TENNESSEE.—Cocke Co., *Kearney*, no. 641 (also somewhat resembles *A. glabra*).

FLORIDA.—Chattahoochee River, *Bush*, no. 13.

13. A. LAEVIGATA Nutt., Torr. et Gray. Fl. N. Am. 1:306. 1838.

The type was found on the "banks of the Arkansas, near Salt River." The description given by NUTTALL is not clear. He says "leaflets distant, elliptical-oblong, attenuated below;" and also "with large distant and very obtuse leaflets." TORREY and GRAY did not see this species, and it seems to me very difficult to clear it up without an original specimen. The interpretation of *A. laevigata* given by BOYNTON in SMALL'S *Flora* (625) is probably not correct; but if it is, *A. californica* and *A. laevigata* would be very nearly allied!

I myself believe that a specimen collected by an unknown gentleman on the banks of the Little Mamelle River, Arkansas, July 1825, which I found in Herb. Engelmann under no. 1043, with the determination *A. laevigata* Nutt., may be the true species of NUTTALL. Most of the leaflets are large and broad-elliptical with a round or slightly cuneate base. Some leaflets are more "suborbicularia" or more "late ovato-lanceolata." The apex is rounded and "fere semper leviter emarginata." The leaflets are rather thin, but firm and smooth and "fere glaberrima." The small fruits are the same as those of typical *A. texana.*

Another quite glabrous specimen is that which has been collected by *E. Hall*, no. 128, eastern Texas, Creek bank, Houston: foliolis minoribus, ad 3.5× 1.8^{cm} magnis. ellipticis, basis subrotundatis vel subcuneatis, apice rotundatis

vel emarginatis, mucronatis; fructibus maturis 5–6^{mm} longis, dorso rectis, satis glanduloso-verrucosis.

Var. PUBESCENS Gray, Pl. Wright. 49. 1852.—*A. fruticosa* var. *subglabra* Gray, Jour. Bost. Soc. Nat. Hist. **6**:174 (the first *subglabra* on this page!) 1850; *A. texana* Buckl. Proc. Philad. Acad. 452. 1861 (sed confer etiam Gray, eod. loco, p. 162. 1862!); *A. subglabra* Heller, Bot. Explor. South Texas 48. 1895.

The type of this variety is the same as *Lindheimer* specimen vi. 47, on a creek near Fredricksburg, Texas; according to my view this is only a variety of *A. laevigata*, if the latter is rightly interpreted above. GRAY (*l. c.*) and HELLER (*l. c.*) state that the true *A. texana* in no way differs from var. *pubescens* (=var. *subglabra* Gray, *l. c.*). I also believe that *Heller's* no. 1772 from Kerr Co., S. Texas, can be best taken as such a variety. There are some more pubescent forms which I name f. **mollis** (=*A. texana* var. *mollis* Boynt. Biltm. Bot. Stud. **1**:139. 1902). To this form belongs a sterile specimen in Herb. Mo. Bot. Gard., with the printed statement "remnants of Buckley's Texas Herb.," and named in BOYNTON'S hand "*laevigata pubescens* Gray."

14. A. PANICULATA Torr. et Gray, Fl. N. Am. **1**:306. 1838.—*A. Roemeriana* Scheele, Linnaea **21**:461. 1848.

TEXAS.—Lynchburg, *Lindheimer*, vii. 42 et (loco non indicato) no. 37. (anno 1843); Gladewater, *Reverchon*, no. 2665; Brazos, *Lindheimer*, no. 18 (anno 1843); Anderson Co., *Eggert*, 11. vi. 99; loco non indicato, *Pammel*, vii. 88; *Drummond*, no. 461 (vel. 261), anno 1835; Marshall, *Bush*, no. 991.

I conclude this account with the words of SCHLECHTENDAHL, which seem to me as true today as they were some fifty years ago: "Quae omnia fusius exposimus, ut inde pateat, quanta sit confusio in hoc genere et quam insufficiens status cognitionis nostrae."

VIENNA, AUSTRIA

RUELLIA AND DIANTHERA: AN ANATOMICAL STUDY

THEO. HOLM

(WITH TWO PLATES AND THREE FIGURES)

Many genera of Acanthaceae have been studied from an anatomical point of view, and the literature is quite extensive. Much attention has been given, for instance, to the occurrence of the peculiar cystoliths, which seem to be especially characteristic of this family; the hairs, which are somewhat variable, have been studied also in a number of genera; and the several cases of anomalous stem-structure have attracted much attention. Suggestions as to an anatomical characterization of the family have been made by VESQUE,[1] but only in connection with the leaves. The anatomy of several Ruellieae has been described by OLGA TCHOUPROFF,[2] and quite a comprehensive anatomical monograph of Thunbergia has been presented by ROULET.[3] With the exception of these works, no others dealing with a general treatment of the family have appeared. Therefore, in spite of the rather copious literature, one does not find more than a few scattered notes on the stem structure in general, relatively very little about the leaf, and almost nothing about the roots. It must be remembered, however, that the authors, as a rule, had to depend on herbarium material or specimens cultivated in botanical gardens.

One species of Ruellia and one of Dianthera are very frequent in the vicinity of Washington, and since these species have not been examined so far, I studied them and found various points that may be of interest to students of plant anatomy. It will be seen from this study that Ruellia has a monostelic structure, which is typical of the stem of dicotyledons; while Dianthera has a polystelic axis. I was very much surprised in finding such structure in a member of

[1] Caractères des principales familles gamopétales tirés de l'anatomie de la feuille. Ann. Sci. Nat. Bot. VII. 1:326.

[2] Quelques notes sur l'anatomie systématique des Acanthacées. Bull. Herb. Boissier 3:550. 1895.

[3] Recherches sur l'anatomie comparée du genre Thunbergia L. fil. Bull. Herb. Boissier 2:259. 1894.

the Acanthaceae, since it is so very rare among dicotyledonous plants, being known only in Nymphaea, Gunnera, Primula (AURICULA), and Pinguicula. In polystelic axes, as described by VAN TIEGHEM and DOULIOT,[4] each stele has its own pith, parenchymatic rays, mestome, and endodermis, and they are all surrounded by a common cortical parenchyma. When the mestome (leptome and hadrome) is distributed in the axis as several isolated strands, and of mestome alone, such structure is called by the same authors astelic; a structure known in Anemone, Ranunculus, Ficaria, Caltha, Hydrocleis, etc.

In Dianthera the steles are very distinct and readily to be recognized as such, since they are cylindric and possess all the necessary elements. In comparing Ruellia, which is a land plant, with the aquatic Dianthera, they are found to be very different, and it is interesting to notice in the latter the combination of characters peculiar to aquatic plants in general and others peculiar to Acanthaceae.

Ruellia ciliosa Pursh.

A woodland type from open woods and thickets, associated with *Silphium trifoliatum*, *Salvia lyrata*, *Galactia pilosa*, etc. The stem above ground dies off in the late autumn (November) and the buds that winter over are subterranean. The rhizome, which persists for several years, is creeping and horizontal, or sometimes ascending; the horizontal direction I believe is most typical of the species, and in this the internodes are very short and almost concealed by the numerous thick roots. When the rhizome is ascending, the internodes are more or less stretched and readily visible. The leaves of the rhizome are very short, scale-like, and membranaceous. Several axillary buds are to be observed on the rhizome; in the larger of these, two or three internodes are frequently so distinct that the term shoots might be more correctly applied to these than buds; however, they remain underground during the winter.

The branching of the rhizome is sympodial, and very regularly so, even in old specimens. The apical internode terminates in an aerial shoot, which dies down to the ground at the close of the season, and the continued growth of the rhizome is secured by the develop-

[4] Sur la polystélie. Ann. Sci. Nat. Bot. VII. 3:275.

ment of an axillary bud. In the accompanying diagram (*diagram 1*), *A* represents the basal portion of the dead stem of 1905; *B*, the aerial shoot of 1906; L^1, opposite leaves of the shoot *A*, and in the axil of the one of these (to the right) a small bud (*b*), while in the axil of the other the floral shoot (*C*) is developed. Shoot *C* has also a pair of opposite, scale-like leaves (L^2), both subtending buds, but of different size, the one behind *C* being the larger (*B*). This large bud (or young shoot) will grow into an aerial stem in 1907, while the two smaller buds (*b*) will remain dormant. The diagram is of a specimen in its fifth year, and not yet blooming.

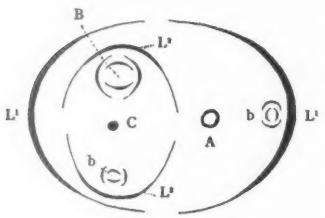

DIAGRAM 1

If we examine the apical portion of a mature specimen with fruits (early in October), the position of the buds is the same as described above, but the number of leaves may be larger. In *diagram 2* the dead stem *A* has one pair of opposite leaves (L^1), the one to the right subtending a bud (*b*), while the one to the left subtends a floral shoot (*C*). This floral shoot bears three pairs of leaves with one large (*B*) and three smaller buds (*b*); *B* corresponds with *B* in the diagram described above, and is situated behind *C*. But *B* is here separated from *C* by two pairs of leaves, and thus is situated somewhat lower than in the other specimen, but occupies the same position behind the floral shoot *C*. The large bud in the axil of L^1 (to the right of *A*), as stated in the preceding, is so far advanced that the internodes are quite distinct, and this bud sometimes develops into an aerial shoot when *C* becomes injured. Otherwise the rhizome does not branch so as to develop

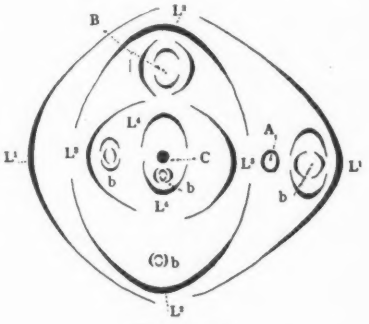

DIAGRAM 2

more than one aerial shoot at the same time; some few specimens I have found, however, where two flowering stems were developed, one of these apical, the other from a bud of a much older portion of the rhizome. Two to five roots develop from the internodes or directly beneath the buds at the nodes.

The rhizome of Ruellia is thus relatively short, when it grows in a horizontal direction, and its power to wander is very limited. Nevertheless one may find several specimens with vegetative shoots in connection with a single rhizome and at some distance from it; such cases are not very rare, but these shoots do not arise from the rhizome, but from roots, and are thus simply root-shoots. The diagram of a root-shoot in its first year (*diagram 3*) shows two pairs of scale-like leaves, one central vegetative shoot (*A*), one large bud (*B*) behind this, and another one (*B*) to the right, while a smaller one (*b*) is situated in the axil of L^1 to the left of *A*. The position of the buds is essentially the same as in the other diagrams, with the exception that the aerial shoot (*A*) occupies here the center of the diagram and the apex of the young rhizome, since this is in its first year of growth.

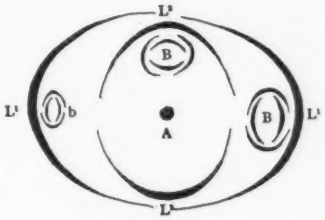

DIAGRAM 3

It is readily seen from these diagrams that in young specimens, in this case a root-shoot, the aerial stem terminates the rhizome in the first year of its growth (*diagram 3*). In older rhizomes, on the other hand, the aerial stem terminates only the apical internode and has actually arisen from the axil of a leaf borne upon the basal internode of the shoot of the preceding year. The shoot *A* is thus always terminal, and always the mother shoot of *C*.

The occurrence of root-shoots has not been recorded for Acanthaceae; at least they are not included in WITTROCK's extensive list of "plants with root-shoots."[5] Three types of such shoots are proposed by WITTROCK: reparative, additional, and necessary; those of

[5] Om rotskott hos örtartade växter. Förhdlgr. Botan. Sällsk. Stockholm. 1883. [Bot. Notiser 1884: 1.]

Ruellia belong to the second type, the additional, which develop spontaneously upon the uninjured plant, and which constitute an important addition to the subterranean vegetative organs. This category of root-shoots is the one that is best known and most frequent; our species of Apocynum illustrate this manner of propagation in a striking degree, and I have seen as many as ten flowering stems of *A. cannabinum* developed upon one single root;[6] it is also the kind so commonly met with in Sassafras, *Rhus Toxicodendron*, Comandra, etc. It may be stated at the same time that the development of additional root-shoots appears to be characteristic of plants in certain localities; for instance, on the plains of Colorado I noticed a remarkably large percentage of plants of various families that exhibited this peculiar mode of propagation.

THE ROOTS

In mature specimens the secondary roots are quite thick, somewhat fleshy, and of a light brown color. The epidermis is thin-walled and somewhat hairy; it covers an exodermis of one layer, which is also thin-walled and whose cells show the same lumen and shape as those of the epidermis. The cortex is differentiated into three distinct zones: a peripheral of three layers of more or less thick-walled cells with many cystoliths; about nine strata inside the peripheral, which consist of thin-walled cells with rhombic intercellular spaces, and of very thick-walled sclerotic cells (*figs. 1, 2*) besides cystoliths, while no raphids were seen, and no deposits of starch; the innermost stratum, represented by a thin-walled endodermis of small cells and with the Casparyan spots very plainly visible.

The sclerotic cells are very characteristic and readily noticeable by their narrow lumen and porous walls; they are stained bright yellow by chlor-zinc-iodin. Similar sclerotic cells are known also from the roots of *Thunbergia annua*, according to ROULET (p. 343). The cystoliths of the Acanthaceae are very well known, and have been described very carefully by SOLEREDER (p. 697). They vary somewhat in outline, from almost quadrangular to fusiform with the

[6] That the horizontal shoot-bearing roots of Apocynum have been mistaken for "horizontal rootstocks" may be seen in MILLER: Dogbanes of District of Columbia, Proc. Biol. Soc. Washington 13:79.

ends obtuse or acute; their surface, however, is always very distinctly granular. Viewed in longitudinal sections the cells containing cystoliths are usually shorter than the sclerotic. The cortical parenchyma of Ruellia thus shows a very characteristic structure.[7]

Inside the endodermis is a thin-walled, continuous pericambium, which surrounds the mestome with its mechanical support of stereome. There are four strands of stereome, each consisting of five to twelve typical stereome cells in one or two layers between the pericambium and the leptome. The leptome itself shows the presence of raphidines, but they seem to be very scarce in this species of Ruellia, since I never found more than one in each cell, and only in a very few places. Raphidines were first described by RUSSOW,[8] who observed them in the root, stem, and leaf of *Hexacentris coccinea*, etc. VESQUE[9] has also described them as characteristic of Cyrtanthera, Meninia, Adhatoda, and Fittonia; while ROULET (*l. c.*) found them in a number of species of Thunbergia. They are also to be observed in Mendoncia and Pseudocalyx, according to RADLKOFER.

The hadrome contains numerous vessels which extend to the center of the root, but secondary formations had already commenced so that the primitive organization of the stele could not be ascertained; however, the four strands of stereome may indicate a tetrarchic structure. Although the specimens of Ruellia were collected as late as the third week of September, no deposits of starch were observed in the roots.

Besides the thick, somewhat fleshy secondary roots, there are some that are quite thin on account of the less development of cortex, which consists only of three strata, thin-walled throughout, with no

[7] A cortex of exactly the same structure has been described and figured by HENRY G. GREENISH (Pharm. Jour. and Trans. London **1891**:839) as representing that of the root of what he took to be *Phlox carolina*. However, the root of that species does not possess cystoliths or sclerotic cells, nor do the roots of any other species of Phlox that I have examined. The rhizomes and roots which GREENISH had before him, and which were sold as those of *Spigelia marilandica*, no doubt belonged to our Ruellia, a plant that has about the same distribution as Spigelia, and whose rhizomes somewhat resemble those of Spigelia. Hence the statement that cystoliths occur in the root of *Phlox carolina* (SOLEREDER, p. 622) may be safely omitted.

[8] Sitzungsber. Naturf.-Gesells. Dorpat **5**:308. 1878–1880.

[9] Sur quelques formations cellulosiennes locales. Ann. Sci. Nat. Bot. VI. **11**: 181.

sclerotic cells, but with a few cystoliths. The stele is composed of three rays of hadrome, and no secondary growth was yet observable.

The capillary, lateral roots are more hairy than the mother root; they have an exodermis whose cells are larger than those of the epidermis and of the peripheral stratum of cortex. The cortical parenchyma is very thin-walled and contains neither cystoliths nor sclerotic cells; the stele shows two rays of vessels with thin-walled conjunctive tissue; but no stereids and no raphidines were observed in these very thin roots.

The roots of the Acanthaceae have been studied only from a relatively small number of genera, and it seems very likely that the structure described above may be observed in several other species of Ruellia and in many other genera of the family, as already indicated in the works of RADLKOFER, ROULET, RUSSOW, and VESQUE.

THE RHIZOME

As stated above, internodes of the rhizome are either very short and horizontal, or stretched and ascending. The latter form shows the following structure: the epidermis is perfectly glabrous and smooth, with the outer cell walls thickened, and some of the cells containing cystoliths; three continuous layers of collenchyma with cystoliths surround the cortex, which consists of five strata, whose thin-walled cells increase in size toward endodermis and contain many cystoliths and raphids, but only a very few sclerotic cells, and no starch; the endodermis is thin-walled and the cells are much smaller than those of the adjoining cortical parenchyma; a few stereids are located inside the endodermis; and the stele shows an almost confluent zone of leptome and numerous rays of vessels (about ten in each row) with narrow parenchymatic rays; a broad, thin-walled pith occupies the central portion of the stele, in which cystoliths and deposits of starch were observed. A longitudinal section of the internode shows the raphid cells to be very narrow, but much longer than the cells of the cortex proper; the cystoliths vary in length, those of the collenchyma being longer than those of the cortical parenchyma, and obtuse or attenuate at each end.

THE STEM ABOVE GROUND

The basal internodes are obtusely quadrangular and hairy with glandular or pointed hairs of the same structure as those of the leaves (*figs. 3, 4*). The cuticle is smooth, and the cells of epidermis are small, somewhat thickened on the outer wall, and contain cystoliths. Five layers of thick-walled collenchyma surround the cortex, which is thin-walled and consists of about nine strata with wide rhombic intercellular spaces; cystoliths and raphids occur in the cortex, but no sclerotic cells and no deposits of starch. A thin-walled endodermis surrounds the stele, which is obtusely quadrangular in cross-section. A few scattered stereomatic cells are located inside the endodermis and outside the leptome. The mestome strands are collateral; the hadrome is represented by short rays of vessels, separated by mostly four rows of thick-walled parenchyma; a few layers of cambium are observable between the leptome and hadrome, but none outside the medullary rays. The central portion of the stele is occupied by a thin-walled pith of large cells, several of which contain raphids and crystals of various forms, prismatic, rhombic, etc., but no cystoliths and no starch.

The structure of the apical internodes differs in a few points from that of the basal portion of the stem. For instance, the collenchyma occurs as separate strands interrupted by the cortex, which is rich in chlorophyll but contains no cystoliths. Moreover, the stereome is better developed in the superior internodes, forming an almost closed sheath inside the endodermis, but outside the collateral mestome bundles.

In the nodes there is a much stronger development of the collenchyma than in the internodes, and the cortex does not break through this tissue so as to reach the epidermis. By comparing the structure of a node with that of the internode below, the following deviations were noticed: there are ten continuous layers of collenchyma in the node, but only five and not continuous in the internode; there are seven layers of cortex in the node, but only five in the internode. The stereome inside the endodermis is reduced to a very few cells in the node, while it is much better represented in the internode. The pith occupies a larger portion of the section in the node than in the internodes. Finally, the cells of the cortex and pith show a wider

lumen in the node than in the internode. The nodes of other genera of the same family have been described by RÜTZOU,[10] who found raphidines in the leptome of Schaueria and Beloperone.

THE LEAF

The ample blade is hairy on both faces, especially on the lower, and along the margins; the ventral face is very smooth, while the dorsal shows a prominent keel from the midrib, and also some of the secondaries (the basal) project on this face. The structure is bifacial in respect to the distribution of stomata and the differentiation of the chlorenchyma.

A very simple and uniform structure is to be observed in the cuticle, which is quite thin and smooth on all parts of the blade; and with the exception of the occurrence of the stomata only on the lower face, the structure of the epidermis is identical on both faces. The lateral cell walls are prominently undulate (*fig. 3*) in the ordinary epidermal cells, or straight in those that contain cystoliths (*fig. 3*). Viewed *en face*, the cells containing cystoliths are readily distinguished by their long and narrow outline and by their contents; they abound especially on the dorsal face, underneath the collenchyma, but they are also very frequent between the veins, above and below the chlorenchyma. Glandular hairs with round pluricellular heads are scattered on both faces, but not so frequent as the very long pointed ones (*fig. 4*). The stomata have two subsidiary cells vertical on the stoma, a structure that is also characteristic of certain genera of Caryophyllaceae. Viewed in transverse sections, the cells of the epidermis are quite large, especially above the palisade tissue; but a considerable decrease in lumen is noticeable in that part of the epidermis that covers the collenchyma, that is above and below the larger veins, where the outer cell wall also becomes moderately thickened. The stomata are raised a little above the adjoining epidermis, and the air-chamber is deep and wide.

The mechanical tissue is represented only by hypodermal strands of a few layers of thick-walled collenchyma, which follow the stronger veins, especially the midrib. No stereome was observed. A thin-walled water-storage tissue occupies the greater portion of the promi-

[10] Om Axeknuder. Bot. Tidsskr. Kjbhvn. 1880–1: 257.

nent midrib, above and below the mestome bundles. This tissue is also represented, though less developed, on the leptome side of the secondary veins, but only the stronger ones that proceed from the base of the midrib.

In proportion to the size of the leaf-blade, the chlorenchyma is very thin and consists of one layer of typical palisades on the ventral face, and of an open pneumatic tissue on the dorsal; the latter is composed of two to three strata of oblong or more or less roundish cells with very wide intercellular spaces. The chlorenchyma is partly interrupted by the collenchyma above the midrib, but the palisades extend for some distance through the water-storage tissue above the mestome bundles of the midrib (*fig. 6*). According to VESQUE (*l. c.*, p. 333), the palisade tissue is continuous, that is, not interrupted by collenchyma, in *Ruellia maculata* and *R. formosa*, in various species of Eranthemum, Strobilanthes, Beloperone, etc., but interrupted, as described above, in Sanchezia, Ebermayera, etc.

All the mestome bundles are collateral; those that constitute the midrib are arranged in a broad arch with the concave face turning upward; the others follow the chlorenchyma in one plane. Only the smallest ones, which are not accompanied by water-storage tissue, have a closed colorless and thin-walled parenchyma sheath. The midrib is composed of several (mostly five) mestome strands, separated from each other by strata pertaining to the water-storage tissue; the hadrome consists of a few rows of rather narrow vessels, with three to four in each row. The leptome (*fig. 5*) is well-represented as several groups underneath the hadrome, and also occurs as small, isolated strands between the hadromatic rays (*L* in *fig. 5*). No closed parenchyma sheath is observable in the midrib, but there is nevertheless an endodermis. This very characteristic sheath is represented here on the leptome side only; it is thin-walled, like the adjoining water-storage tissue, and shows very plainly the spots named after Caspary. Without forming a closed sheath, the endodermis thus forms an arch parallel with the keel, and ceases outside the leptome of the two outermost mestome strands. A like structure in regard to the open endodermis in the midrib is described by ROULET (*l. c.*) as characteristic of certain species of Thunbergia, for instance, *T. fragrans*, *T. hastata*, and *T. hirta*.

The portion of the blade described above was near the middle, where the leaf is broadest; however, the structure is essentially the same throughout. At the narrow apex there is only a decrease in width of the collenchyma, the water-storage tissue, and the midrib, which consists only of three almost confluent mestome strands; while the chlorenchyma has not undergone any change.

Characteristic of the leaf of our Ruellia, therefore, is the interruption of the chlorenchyma by the collenchyma, and the presence of isolated leptomatic strands between the rays of hadrome. The structure of the stomata, the presence of glandular and long pointed hairs, and the cystoliths are, so far as we know, characteristic of Acanthaceae in general.

THE PETIOLE

A transverse section of the very short petiole shows an approximately crescent-shaped outline, the ventral face being almost flat in contrast with the dorsal, which is obtusely carinate. The structure is almost identical with that of the midrib in the blade. Glandular and pluricellular pointed hairs occur also, and two or three strata of thick-walled collenchyma follow the outline inside the epidermis. A colorless, thin-walled water-storage tissue occupies the greater portion of the section, and the mestome bundles are arranged in an arch as in the midrib, while two very small strands of mestome are located in the thin margins, surrounded by chlorophyll-bearing parenchyma.

Cystoliths are abundant in the epidermis, but are absent from the colorless parenchyma, in which only raphids and some long prismatic crystals were noticed. On one side of the broad arch-shaped midrib two wide sclerotic cells were observed, and a few raphidines in the leptome.

Dianthera americana L.

This species is very frequent in the vicinity of Washington, D. C., where it grows in creeks and in the Potomac River, generally associated with Saururus, Sagittaria, *Pontederia cordata*, etc. It has a very long, horizontally creeping rhizome, with opposite, scale-like leaves and stretched internodes of an obtusely hexagonal outline. Secondary roots, from four to eight or even more, are developed at

the nodes, but not directly underneath the leaves, mostly between them; the roots are quite thick and long, and branch freely. The rhizome represents a sympodium, being terminated by a floral shoot, which dies off at the end of the first season; axillary buds occur on the rhizome and at the base of the aerial shoot, and these winter over and continue the growth of the rhizome at the beginning of the next season.

The germination seems to be unknown, and I regret to say that I have never succeeded in studying the young stages of this common plant.

THE ROOTS

As described above, the rhizome is amply provided with roots (secondary), that are quite thick and much branched; they remain active for at least two years and represent a combination of storage and nutritive roots, but are not contractile. The internal structure of these secondary roots exhibits very plainly the features characteristic of roots of aquatic plants. The epidermis is very small-celled and glabrous. The exodermis consists of three very distinct strata (*fig. 8*) of polygonal cells with the walls slightly thickened and deep brown, but with no foldings. The cortical parenchyma is thin-walled and consists of about seventeen layers, the cells very regularly radially arranged and traversed by wide lacunes from the radial collapsing of several of the strata; the outermost layer of the cortex and the innermost three usually remain intact. Small quantities of starch, but no crystals, were observed in the cortex. The stele shows a thin-walled endodermis and pericambium, which was never found to be interrupted by the proto-hadrome vessels. Although these roots have increased in thickness, the primitive organization is yet quite distinct, there being mostly five rays of hadrome with old vessels. The cambial arches inside the leptome (*fig. 7*) are readily visible, as well as the very thin-walled young vessels. The leptome is well represented, and in several cases it appeared as if there were two proto-leptome cells in each strand. A thin-walled conjunctive tissue occupies the inner portion of the stele like a central pith.

No crystals were observed in any parts of these roots, nor any sclerotic or stereomatic cells; in the leptome, however, a few raphidines were noticed, but only in some of the roots. By studying the

same root at different places, I noticed that the collapsing of the cortex does not take place in the entire length of the root, but only in the basal (thickest) portion. The occurrence of rhapidines is very variable; in some roots they were observed only in the younger apical portion; in others they were found also in the basal.

The lateral roots of the first order show the same structure as the mother root, but the number of strata in exodermis and cortex is generally smaller. The exodermis, for instance, may be represented by only a single layer, but sometimes three are found, as in the mother root. The cortex may be solid or collapsed, and may be reduced to only three strata. The epidermis does not differ from that of the secondary root, and is glabrous. The endodermis is thin-walled, and the secondary formations are usually not so advanced but that the primitive organization may be readily observed to be diarchic or tetrarchic.

A corresponding structure is to be found in the lateral roots of the second order. They are capillary and have a glabrous epidermis and an exodermis of two layers. The cortex consists of three thin-walled strata, which are collapsed at the base of the root, but entire near the apex. Inside the continuous pericambium are a few stereomatic cells, mostly only two, diametrically opposite each other. The leptome is represented by two broad strands alternating with two rays of hadrome with two wide reticulate vessels in the center, and about three scalariform outside. No secondary growth takes place in these roots.

If it were not for the presence of raphidines, the root of Dianthera would be utterly unlike that of Ruellia described above. Moreover, the habitat of Dianthera is naturally the cause of the very different development of exodermis and cortex, and of the absence of cystoliths, sclerotic cells, and crystals.

THE STEM

The rhizome with the stolons and the ascending aerial shoots show the same structure in general, and, as stated above, the axis is polystelic.[11] This peculiar structure was observed in all the inter-

[11] A polystelic stem is also possessed by *Dianthera crassifolia* Chapm. and *D lanceolata* (Chapm.) Small, but not by the following species: *D. comata* L. (Porto

nodes of the rhizome and of the ascending shoots, in the slender as well as in the more or less swollen portions of the vegetative axis. In the nodes the polystelic structure becomes somewhat obscured by the anastomoses of the steles; nevertheless, the presence of several steles is usually recognizable.

In outline the rhizome is obtusely hexagonal and smooth; no stomata, but small, sessile glandular hairs were observed. Formations of cork develop from the epidermis, including the cells with cystoliths (*fig. 16*). Inside the epidermis there is a continuous zone of very thick-walled collenchyma of about six layers, bordering on the cortical parenchyma. The cortex consists of numerous strata of thin-walled cells, which are round in transverse sections and with relatively wide intercellular spaces (*fig. 17*); starch was observed in the cortex, and numerous bundles of true raphids, but no chlorophyll. Throughout the internodes of the rhizome (and also of the aerial shoots) the cortical parenchyma represents a homogeneous tissue from the periphery to the central portion, whether a central stele is present or not. No central pith is differentiated in the internodes except where there is a central stele, also a small tissue of this parenchyma is to be found in the peripheral steles. It appears as if the horizontal internodes of the rhizome have always six peripheral and one central stele; these steles are cylindrical and each is surrounded by a thin-walled endodermis with the Casparyan spots plainly visible and with deposits of starch. Inside the endodermis are a few cells of thick-walled stereome, but too few to form a sheath. In the peripheral steles the leptome and hadrome form an almost complete ring, with a small central pith; in the central stele, on the other hand, the mestome is arranged in two arches, with a broad parenchyma in the middle.

Between the leptome and hadrome are a few strata of cambium, and between the strands of mestome are three or four rays of thick-walled parenchyma. Raphidines (*fig. 18*) were observed very frequently in the leptome.

Rico), *D. glabra* B. et H. (Costa Rica), *D. incerta* Brandg. (Lower Calif.), *D. ovata* Walt. (Florida), *D. parvifolia* B. et H. (Texas), *D. pectoralis* Murr. (St. Croix), and *D. sessilis* Gray (St. Domingo). Of these nine species I had only dried material, which was quite sufficient for a study of the steles, but not of the anatomical structure in general.

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In a stolon, terminated by an over-wintering bud, I found the same structure as described above as characteristic of the main rhizome, the only difference being that the collenchyma was less thick-walled; that the cortex contained large deposits of starch; and that the central stele showed very prominently three arches of mestome (leptome, cambium, and hadrome) separated from each other by very broad rays of thin-walled parenchyma. While the hadrome in this stele was thus confined to three arches of collateral mestome strands, the leptome was developed as isolated groups inside the endodermis, not only oustide the hadromatic rays, but also between them.

While thus the peripheral steles of the main rhizome and the stolons show an almost equal development of collateral mestome strands around a central pith, the stele in the center shows the hadrome more or less distinctly combined in arches (two or three), while the leptome follows the entire periphery inside the endodermis (*fig. 14*).

A corresponding structure is to be found in the aerial shoot which bears the long, narrow leaves and the inflorescences. In the apical internodes, for instance, we find the same tissues and arranged in the same manner, but the change of medium naturally brings about certain modifications of structure. In the rhizome and in the submerged portion of the ascending shoots the cortex does not reach the epidermis, but is completely inclosed by the collenchyma. In the aerial internodes, on the other hand, the cortex extends to the epidermis, thus breaking through the collenchyma, which here becomes developed as isolated strands, as prominent ridges; where the cortex reaches the epidermis it develops typical palisades, which contain much chlorophyll (*fig. 21, C*).

The cuticle is very smooth and thin in the aerial internodes. The epidermis has stomata and glandular hairs, and contains cystoliths. The collenchyma is very thick-walled and forms eight prominent strands of about ten layers; six of these strands correspond with the six peripheral steles, while the remaining two, which are somewhat smalier than the others, are diametrically opposite each other and between two steles. The cortex is differentiated into one or two strata of palisades, located in the furrows between the collenchymatic ridges; the inner portion of the cortex contains less chlorophyll

and the cells are more roundish in cross-sections; while the innermost, which occupies the greater portion of the internode, is a very open tissue with no chlorophyll, but with some small deposits of starch. The intercellular spaces are quite wide and the general structure of the cortex agrees with that of an aquatic plant. Six peripheral steles are located inside the six collenchymatic strands, while a seventh occupies the center of the internode. They are all orbicular in transverse sections and each has a thin-walled, completely closed endodermis, inside of which is another sheath of about two layers of thin-walled stereomatic tissue. The mestome bundles of the peripheral steles are collateral and arranged in an arch toward the periphery of the stem, while the inner face of the steles is occupied by a pith and a few scattered strands of pure leptome (*fig. 14, L*). The central stele shows the same structure as the peripheral. *Fig. 13* shows the mestome of one of the peripheral steles; there are a few strata of cambium inside the leptome, and some young (three) vessels besides older ones in two rays with thin-walled parenchyma between. The node above this internode shows at once a change in the disposition of the steles, that is, four of the peripheral have fused together in pairs so as to form two large steles of triangular outline, while the central and the remaining two peripheral are unchanged. The steles that thus fuse together in the node are those of the internode which are marked *S* in *fig. 9*, and between which there is an isolated strand of collenchyma.

In this node the thin-walled collenchyma surrounds the cortex completely, which is here almost destitute of chlorophyll and which represents a more compact tissue than in the internode below. No raphidines were observed in the node, but many crystals of various kinds, needle-shaped, rhombic, prismatic, etc., abound in the pith of the broader steles.

A dilation of some of the steles thus takes place in the node, resulting in the gradual concrescence of two steles on each side of the node. From the union of these steles each of the two opposite leaves receives three mestome cylinders, readily observed in the petiole as one central, very broad, and arch-shaped cylinder, with a much smaller one on either side. By following the structure of several internodes of a single shoot, I noticed that the central stele is not

present in all of them. Sometimes this central stele was observed in every other internode, but I found also some cases where the apical and basal internodes possessed such a central stele, but not the two internodes between them.

In the basal internodes of the aerial shoots the structure of the stele becomes more regularly developed, the leptome and hadrome forming an equally broad ring around the central pith, which consequently becomes much reduced in width; in other words, these steles show exactly the same concentric and uniform structure as the central stele of the monostelic axes.

In very small vegetative shoots, developed in the axils of the leaves of the larger floral ones, the structure is as described above, but the number of steles may vary. For instance, in a shoot consisting only of two short internodes, the basal one contained only four steles, all peripheral, while the upper one had one central, two large peripheral, and two still broader ones, each of which consisted of two that had partly fused together; the latter corresponding in position with the four marked *S* in *fig. 9*. In these internodes the structure and disposition of the collenchyma and cortex was exactly as described above.

In order to ascertain the number of steles in the stem of Dianthera, I examined shoots of very different height and thickness, but the number never exceeded seven—six peripheral and one central. A very thick branch with two opposite and equally robust shoots showed seven steles above and below the node, and also in the two lateral shoots. It is somewhat surprising to see that this polystelic structure ceases at once when the axillary shoot is an inflorescence and not a vegetative branch. The short inflorescence of *Dianthera americana* is borne upon a long, naked internode, and this internode is monostelic from base to apex. In this the cortex incloses completely one broad central cylinder with one zone of leptome and one of hadrome, with parenchymatic rays of equal size and with a central cylindric pith, as is characteristic of monostelic axes.

In the genus Primula the Danish botanist VAUPELL[12] detected the polystelic structure in *P. Auricula*, and VAN TIEGHEM and DOULIOT

[12] Om Rhizomets Bygning hos *Primula auricula* og *chinensis*. Vidensk. Medd. Naturhist. For. Kjöbenhaven 1849:76; and Untersuchungen über das peripherische Wachsthum der Gefässbündel der dicotyledonen Rhizome. Leipzig. 1855.

(*l. c.*) have extended his observation to a large number of species of various sections of the genus. One of the results of their investigation is that a complete accordance exists between the external and internal structure of these species of Primula. These authors proposed the reestablishment of TOURNEFORT'S genera Primula and Auricula, the former characterized by possessing a monostelic, the latter a polystelic, axis. Whether this same peculiarity in the stem structure, which I have found in *Dianthera americana*, *D. crassifolia*, and *D. lanceolata*, may be used in classifying the species under two distinct genera, I must leave to future investigators to decide, who have access to more abundant material.

THE LEAF

The narrowly lanceolate and almost sessile leaves are held in a vertical position above the water; they are smooth and glabrous on both faces, while along the margins unicellular, short, pointed hairs occur; over these hairs the cuticle is granulous, but smooth and thin above the epidermis of both faces of the blade. There are only a very few of these hairs, and they were observed only on young leaves.

The leaf is neither exactly dorsiventral nor unilateral, when the distribution of stomata and the structure of the chlorenchyma are considered; the stomata are just as frequent on the ventral as on the dorsal face, and some palisade cells occur here and there inside the dorsal epidermis. Viewed *en face* the cuticle shows no striations, and the lateral cell walls of the epidermis are somewhat undulate on the dorsal face, but almost straight on the ventral; small glandular hairs (*fig. 10*) occur on both faces of the blade. The stomata are not arranged in any way so as to be parallel with the longitudinal axis of the leaf; and they have two subsidiary cells vertical on the stoma. *Fig. 12* shows the commonest form of the outline of the subsidiary cells, which seems to be less regular and more variable on the upper face of the leaf than on the lower. Viewed in transverse section, the outer wall of the epidermis is slightly thickened, and the lumen of the cells is wider on the upper face; the stomata are raised a little above the adjoining epidermis, and have a deep and wide air-chamber. In the lateral parts of the blade, which are much thinner than the median with its broad and thick midrib, the chlorenchyma (*fig. 22*)

shows one layer of typical palisades above a pneumatic tissue of roundish to more or less oblong cells with wide intercellular spaces. However, the stratum of pneumatic tissue which borders on the dorsal epidermis is in some places developed almost as palisades, the cells being more regularly oblong and more compact; as will be shown later, a palisade tissue is very typically represented on both sides of the dorsal keel of the midrib. No crystals were observed in the mesophyll, but long fusiform cystoliths are frequent in the epidermis, especially on the dorsal face.

Collenchyma and stereome seem to be entirely absent from the lateral portion of the blade, and thus the lateral veins are directly imbedded in the chlorenchyma. They are very fine, orbicular in cross-section, and surrounded by a thin-walled, colorless parenchyma sheath.

A more complicated structure is to be found in the median portion of the blade with the strong midrib. Near this part of the blade the leaf is thicker, due to an increase in height of the palisade tissue, while in the midrib a prominent broad and very obtuse keel is to be observed on the dorsal face, and a similar, though much less projecting one, on the ventral. The epidermis is very small-celled in this part of the blade and covers a broad strand of thick-walled collenchyma in about three layers on the dorsal face. There is also collenchyma on the ventral face, and this is extremely thick-walled and represented either by two separate strands near the middle, or by a single one exactly above the center of the midrib. A large, thin-walled colorless tissue occupies the greater portion of the keel, but occurs also above the mestome bundles which compose the midrib. The chlorenchyma is on faces of the midrib interrupted by the collenchyma; it occurs as two strata of high palisades on the ventral face, and as one or two strata of lower palisades (*fig. 23*) in the sides of the keel; thus, as stated above, this tissue is not confined to the ventral part of the blade alone. The pneumatic tissue is also well developed, but only near the dorsal keel. There are three mestome bundles in the midrib; one very broad, in transverse section crescent-shaped with the concave face turned upward, and two very small lateral ones, orbicular in cross-section. A thin-walled endodermis covers the leptome side of these three mestome strands, but not the hadrome.

In the middle there is an arch of thin-walled stereome in two or three layers between the endodermis and the leptome. The leptome has very narrow sieve tubes and companion cells, and the hadrome consists of rather narrow vessels in many short rays. In the two small mestome bundles the mestome is less developed, and there is no stereome. Raphidines abound in the leptome of all three veins, sometimes filling the cells completely.

There are thus in the leaf of Dianthera several features indicating the immediate relationship of the genus, illustrated by the structure of the stomata and the presence of raphidines and cystoliths. The distribution of stomata and palisades on both faces of the leaf at least points toward the general structure of an aquatic plant.

THE PETIOLE

There is a short but very distinct petiole, which is approximately hemi-cylindric in outline, the convex face being the dorsal. The internal structure is almost identical with that of the midrib. There are the same tissues of the same development, but distributed in a somewhat different way; for instance, the collenchyma surrounds the colorless parenchyma almost completely, being interrupted only by one narrow group of palisades in the middle of the ventral face, and by two small groups of the same tissue on the sides of the carinate dorsal, and very near its edges. There are three mestome strands in the center, the outline and minor structure of which agree in all respects with the midrib. The petiole has no stereome; cystoliths were found in the epidermis and raphidines in the leptome.

Summary

With the exception of the polystelic axis in Dianthera, the structure of the two plants agrees well with that of Acanthaceae in general as recorded by SOLEREDER, namely, the type of stomata, the glandular and simple hairs, the cystoliths, the raphidines, the various crystals of calcium oxalate, etc. These characters are some of the most important for distinguishing the family.

Although Ruellia and Dianthera possess the principal characteristics of the family, the very different environment in which they live has been the immediate cause of several modifications in structure.

In Ruellia the structure is that of a land plant as follows: the hairy root with a solid cortex and with many sclerotic cells; the very hairy stem with a closed sheath of stereome inside the endodermis; the very hairy leaves held in a horizontal position and with a strictly bifacial structure in regard to stomata and palisade tissue. In the aquatic Dianthera, on the other hand, the roots are glabrous (at least in adult specimens) and the cortex is collapsed; the stem has only small, glandular hairs and the cortex shows intercellular spaces of sometimes enormous width; the narrow leaves are held in a vertical position and are approximately isolateral, so far as concerns the stomata and palisade cells; in addition to the glandular hairs only very short and mostly unicellular hairs cover the margins of the younger leaves.

BROOKLAND, D. C.

EXPLANATION OF PLATES XI AND XII

Ruellia ciliosa

PLATE XI

FIG. 1. Transverse section of root, showing sclerotic cells in the cortical parenchyma. ×320.

FIG. 2. Longitudinal section of a sclerotic cell. ×320.

FIG. 3. Epidermis of lower face of leaf, showing two stomata, a cystolith, and a glandular hair, viewed *en face*. ×320.

FIG. 4. Hair from lower face of leaf. ×240.

FIG. 5. Transverse section of part of midrib of leaf, showing the leptome extending between the hadromatic rays: *end*, endodermis; *l*, leptome; *h*, hadrome. ×560.

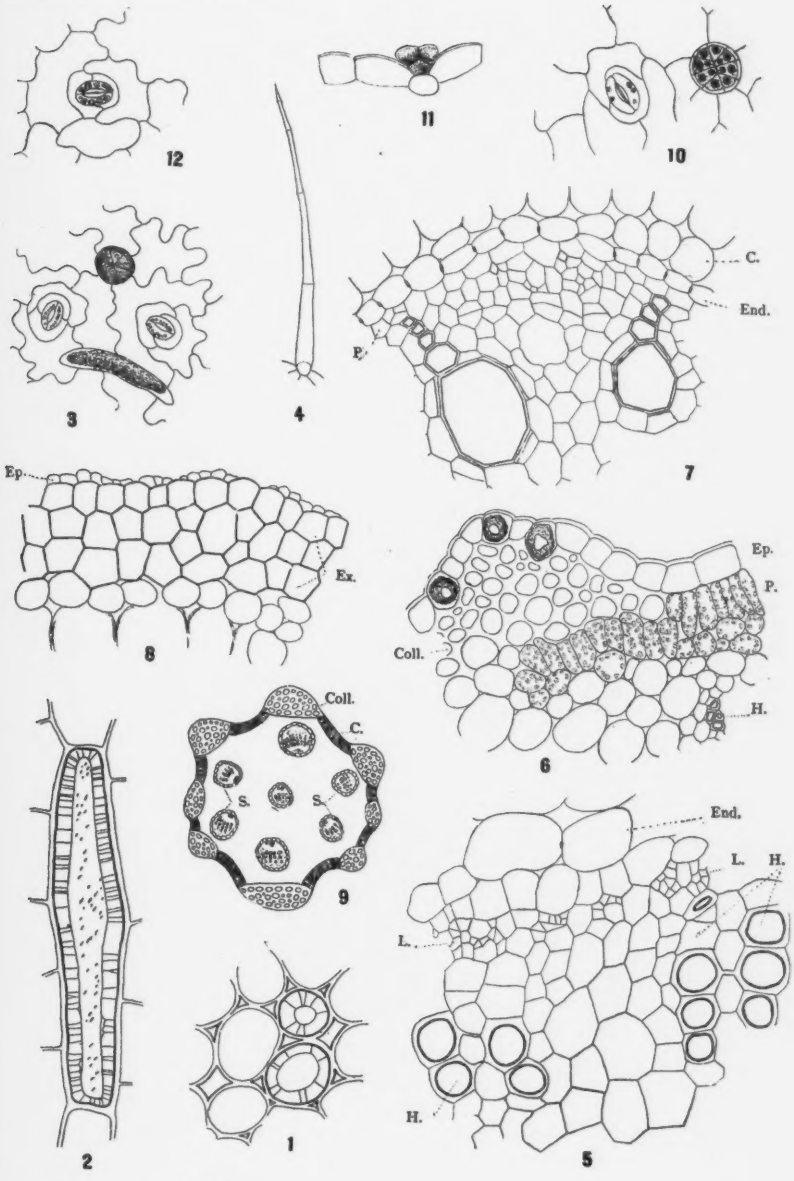
FIG. 6. Transverse section of part of leaf, showing the palisade tissue (*p*) extending above the midrib: *h*, the hadrome of the small lateral mestome bundle; *coll*, collenchyma. ×230.

Dianthera americana

FIG. 7. Transverse section of a secondary root, showing the beginning of growth in thickness: *c*, cortex; *end*, endodermis; *p*, pericambium; between the two rays of vessels and inside the leptome is an arch of cambial tissue and a young, wide, and very thin-walled vessel. ×496.

FIG. 8. Transverse section of a secondary root: *ep*, epidermis; *ex*, exodermis of three layers. ×320.

FIG. 9. Transverse section of stem internode, showing eight strands of collenchyma (*coll*) separated by palisades, the peripheral strata of cortex (*c*), and



Auctor ad nat. delin.

HOLM on RUELLIA and DIANTHERA

seven steles, one in the center, six near the periphery; *s* and *s*, the four steles that fuse together in the node.

FIG. 10. Epidermis of upper face of leaf, showing a glandular hair and a stoma, viewed *en face*. ×320.

FIG. 11. Epidermis and a glandular hair of leaf, transverse section. ×320.

FIG. 12. Epidermis of lower face of leaf with a stoma. ×320.

PLATE XII

FIG. 13. Transverse section of stem internode, showing part of peripheral stele: *c*, cortex; *end*, endodermis; *st*, stereome; *l*, leptome. ×400.

FIG. 14. The innermost face of same stele (*fig. 13*), showing the continuous endodermis, some strands of leptome (*l*), and the large, thin-walled pith (*p*). ×400.

FIG. 15. Tranverse section of stem internode, showing the locally, very heavily thickened cell walls of the collenchyma inside epidermis (*ep*). ×320.

FIG. 16. Transverse section of rhizome, showing beginning formation of cork in epidermis (*ep*). ×320.

FIG. 17. Cortex of rhizome, transverse section. ×75.

FIG. 18. Transverse section of rhizome, showing endodermis (*end*) and leptome with raphidines. ×560.

FIG. 19. Transverse section of a node (submersed), showing the very thick-walled, branched cells of cortex. ×240.

FIG. 20. Tranverse section of an internode (submersed), showing the open cortex. ×75.

FIG. 21. Transverse section of an aerial internode, showing collenchyma (*coll*) and palisades of cortex (*c*). ×320.

FIG. 22. Transverse section of lateral portion of leaf, showing the ventral epidermis (*ep*) and the palisdae tissue (*p*); below is the pneumatic tissue and dorsal epidermis. ×240.

FIG. 23. Transverse section of leaf, showing palisades inside the dorsal epidermis (*ep*), and underneath the midrib. ×240.

FIG. 24. Stoma of upper face of leaf. ×320.

THE IDENTITY OF MICROCYCAS CALOCOMA

OTIS W. CALDWELL AND C. F. BAKER

(WITH THREE FIGURES)

The important discoveries made in the Cycadales within the past decade led the first author to desire to secure material for a morphological study of Microcycas. During March and April of 1905 an abundance of staminate and carpellate cones as well as vegetative material of a small cycad said to be *Microcycas calocoma* were collected in Cuba. It was questioned immediately whether this material did not belong to Zamia. A careful comparison with herbarium specimens and an examination of literature soon led to the conclusion that it was *Zamia pumila*. Later investigation fully confirmed this conclusion and showed that it has been wrongly called *Microcycas calocoma*. Specimens of what is probably *Zamia pumila* have been issued several times from the New York Botanical Garden as *Microcycas calocoma*, the specimens coming from Madruga (*Britton* and *Shafer* 638 and 803) and from Matanzas.

In January and February 1907 a second attempt was made to locate and collect material of *Microcycas calocoma*, this excursion resulting more successfully than the first. In the higher regions of the Sierras of western Cuba a number of groups of the plant were found, also both staminate and carpellate cones. The confusion that exists in reference to the genus and the incompleteness of published accounts make desirable a somewhat full account of its bibliography and characters.

The earliest description discovered is that of MIQUEL in VAN HOUTTE'S *Fl. Serres et Jard.* (7:141. 1851–52), under the title "Sur une espèce nouvelle de Zamia des Indes occidentales, introduite dans l'establissement Van Houtte, à Gand." Although he gave this plant the name *Zamia calocoma*, in this same connection he suggested that there be made for it a new section of the genus, to be called Microcycas. In a note preliminary to the description MIQUEL says that this plant constitutes quite a distinct species, near *Z. tenuis*

Willd., but differing from it in the form and number of the leaves. In this character MIQUEL says that *Z. calocoma* surpasses all other species of the genus, and "rappelle parfaitement le port d'un petit *Cycas revoluta*." MIQUEL's description is as follows:

Zamia calcoma Miq. Frondibus adultis glabris, pinnis densis numerosissimis, utrinque 65–70, coriaceis linearifalcatis subacutis integerrimis, marginibus leviter incurvis, utrinque tenere nervoso-striulatis, nitidis.—Sectio nova: *Microcycas*.

Adumbratio speciminis in Horto Amstelodamensi culti.

Truncus 10 poll. altus, basi 4½ crassus, subconicus, simplex vel bifidus, fere totus esquamatus, cortice hic illic lenticelloso-pustuloso, pallido, superne perulis coriaceis sensim rigescentibus lanceolatis acuminatus ochraceo-griseo-tomentosis, glabrescentibus, circa frondium comam obvallatus. Frondes nunc undecim, erecto patentes. Stipes subtrigono-cylindraceus vel ferme cylindricus, antice non vel obsoletissime sulcatus, 3–4 poll. longus, calamum scriptorium crassus, juvenilis villo arachnoideo tenui tectus, adultus glaberrimus. Rhachis 1¼–1½ pedalis, rectiuscula vel flexuosa, subsemitereti-trigona, dorso valde convexa, antice interpinnas in angulum obtusum prominens, sulco utrinque pro inserendis pinnis haud profundo, apice in brevem mucronem incurvulum vulgo quidquam pilosum exserta. Foliola articulatione mox pallescente subtumidula inserta, senescentia seorsim decidua, media longiora quam superiora et inferiora (hinc tota frons lanceolata fere), omnia densa, pleraque alterna vel superiora subopposita aut opposita, horizontaliter patentia, saepe retrorsum arcuato-curvata, 3–11 in. distantia, infima paulo distantiora, linearia, rigidule coriacea, fere omnia falcata, supra saturate viridia, laevia, nitida, facie plana vel leviter canaliculata, subtus pallida, marginibus praesertim versus basim leviter recurva, utrinque tenere striata nervis parallelis in medio 12, versus, apicem folioli saltem 5, saturate viridibus: omnia integerrima: media 4 poll. longa vel aliquid longiora, 1½–1¾ lin. lata. In plerisque frondibus utrinque 60–70 foliola numerantur.

In *Gartenflora* (**6**:16. *pl. 186. fig. 30.* 1857) REGEL mentions *Zamia calocoma*, but with no description. In 1857, however, he gives a brief description (Bull. Soc. Nat. Mosc. **1**:191), based upon a specimen of *Zamia calocoma* which he says was brought from Cuba by CHAPPY. In addition to the characters given by MIQUEL, REGEL adds that the stem is one to two feet high and shows for a long time the markings left by the successive crowns. He also states that dormant buds appear on the stem. In closing he says that this plant varies so widely from any Zamia that it may constitute a new genus, and that he hoped his specimen would soon flower and thereby enable him to decide the question.

GRISEBACH (Cat. Pl. Cub. 217. 1866) refers to a further collection

FIG. 1.—A young plant, two ovulate cones, one staminate cone (standing at right of left-hand cone), and terminal bud (at base of staminate cone); comparative sizes are shown by herbarium driers used as support for specimens.

by WRIGHT as follows: "*Zamia calocoma* Miq. (*Wr.* 3193: foliola pleraque 8″ longa 4″ lata; squamis ad *Z. Brongiartii* Miq. accedit)."

In DE CANDOLLE'S *Prodromus* (**16**[2]:538. 1868) there appears the first full account of Microcycas as a distinct genus, the description being based upon previous descriptions and upon material collected by WRIGHT. From this we make the following excerpts:

Squamae strobili masculi planae, imbricatae? crassiusculae, a basi ad mediam partem cuneatae et subtus crebre loculigerae, a medio ovatae, steriles. Squamae strobili feminei laxe juxtapositae, axi perpendiculares, superiore majore parte drupam irregulariter sulcatam simulante, nempe ellipsoideo-costatae et sulcatae, extremitate truncata vel obtusa, inaequaliter (in sicco?) bullata, basi in stipitem brevem angustata, stipite utrinque in apice semen ellipsoideum sessile gerente.—Arbuscula Antillana; trunco humili . . . . nunc fructificatione cognita, genus inter Dioon et Zamiam apparet, a priore diversum foliolis basi segregatis et articulatis, squamis femineis pinguibus, apice contundatis et seminibus ut vulgo sessilibus; a Zamia, squamis masculis planis, non peltatis, femineis pelta multo longiore.

Under the description of the species (*M. calocoma* (Miq.) A.DC.) the following statements appear:

Strobili masc. forma mihi ignota. Squamae (segregatae) 18–20 mill. longae, 9–10 mill. medio latae; parte fertili centim. longa, supra glabra, subtus undique loculis vestita; parte sterili cinereo-tomentosa, supra in nervum crassum medio inflata. Strobilus femin. 2 decim. longus, cylindricus? (in specimine sectus), pedunculo cinereo-tomentoso brevi? suffultus. Squamae 2 cent. longae, stipite 4–5 mill. longo, reliqua parte 15 mill. longa, 9–10 mill. lata, costis irregularibus latere sup. magis convexo, apice aut, planiusculo subquadrangulo, aut contundato-sinuoso, pallide pilis stellatis tomentoso.

BENTHAM and HOOKER (Gen. Plant. **3**:447. 1880) give an incomplete and imperfect characterization of the genus, and incorrectly cite the name of the species as *cubensis*.

From the above descriptions it is clear that our material is *Microcycas calocoma;* but it is also evident that the specimens used as a basis of these descriptions were far from being fully representative. There are two specimens of *Wright* 3193 in the Wright-Sauvalle herbarium, one of which possesses a young fruit. This is the number cited and described by DE CANDOLLE, and is identical with our own collections.

The following description is based upon our material:

Stem 25^{cm} to 10^{m} high, $1–6^{dcm}$ in diameter, often branched; bark

smooth or ridged, usually with conspicuous leaf scars; cross-section showing a thick cortex, a single vascular cylinder, and pinkish, brittle, starch-bearing pith: leaves 0.6 to 1^{m} long, 6–40 in the crown; petioles

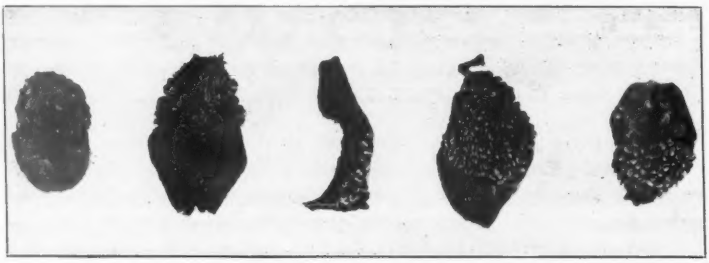


FIG. 2.—Staminate sporophylls; the two at the left show the adaxial surface, the two at the right the abaxial surface, the middle one a lateral view.

1^{dcm} long, terete, with shield-like base; leaflets 50–80 pairs, 8–12^{cm} long, opposite or alternate, attached by an entire calloused base, finely villous when young, glabrous and glistening when mature, bright

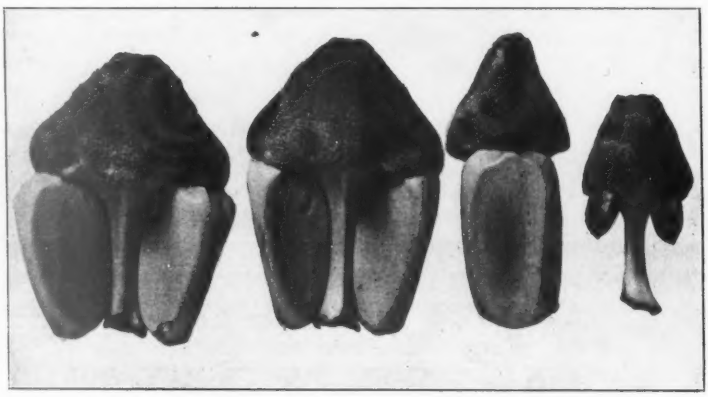


FIG. 3.—Ovulate sporophylls, showing (beginning at the left) abaxial view, adaxial view, lateral view, and abortive ovules.

green, with 15–20 dichotomously branching veins (reduced to 6–8 at the tip), bluntly pointed, tips turning inward slightly, margin slightly revolute: bud scales 4–6^{cm} long, 1.5–2^{cm} wide, often twisted at tip,

densely tomentose (except on lower half of inner face) with long gray hairs: staminate cone 25–30^{cm} long, 5–8^{cm} in diameter, cylindrical, on a short densely tomentose peduncle; sporophyll 2–2.5^{cm} long, 1.5–2^{cm} wide, the basal two-thirds of the abaxial surface densely covered by sporangia, the apical third gray-tomentose and prominently ridged along the median line, obtusely pointed: ovulate cone 50–70^{cm} long, 13–16^{cm} in diameter, cylindrical, slightly tapering from base to tip, obtusely pointed, on a short densely tomentose peduncle which together with the base of the cone is covered by densely tomentose scales 6–10^{cm} long; sporophyll 4.5–5.5^{cm} long, 3–4^{cm} wide, 2–3^{cm} thick, with stalk 3–3.5^{cm} long and perpendicular to the axis of the cone, the outer portion quite convex, usually four-ridged, the apex blunt, sub-quadrangular, and sometimes furrowed, the entire outer portion of the sporophyll covered by a dense mass of closely appressed grayish hairs; ovules two, pink, 3.25–3.5^{cm} long, 1.25–1.75^{cm} thick (*figs. 1–3*).

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BRIEFER ARTICLES

LINNAEUS[1]

MAY 23, 1707—JANUARY 10, 1778

(WITH TWO PORTRAITS)

The history of scientific progress has been marked by a few epochs introduced by new and revolutionary ideas. After a long period of almost no advancement, science has suddenly been carried forward in a most remarkable way. Such epochs have been few, and few are the men who have continued to be held in highest esteem with the steady progress of modern science. Among them was one who rose from humble descent to become the leading naturalist of the eighteenth century, and whose name is still among those most revered wherever natural science is taught or cultivated—LINNAEUS. Now that the day is at hand when his two-hundredth anniversary is to be observed throughout the scientific world, a brief sketch of his life and work is appropriate.

Between Lindshult and Jonsboda, in Sweden, there stood formerly an old and very large linden tree from which two brothers, the sons of a peasant, INGEMAR SVENSSON, adopted the surname TILIANDER; from this same tree their sister's son, NILS INGEMARSSON, took the name LINNAEUS. NILS INGEMARSSON was a minister, and his first living was in Raashult, the parish of Stenbrohult in Smaaland. He married CHRISTINA BRODERSONIA, and their first-born child was a boy who was christened CARL LINNAEUS. From his early childhood this boy showed an unmistakable love for flowers. His father was quite interested in botany and took pride in making the little garden of the parsonage one of the richest in flowers and rare shrubs. At the age of about four years CARL accompanied his father to a meeting; it was a fine summer day, and his father gathered several plants which he demonstrated before the guests, showing the peculiar roots of some orchids, Succisa, Tormentilla, and others. This little lecture in botany made such an impression upon the boy that he afterward never gave his father any peace, but repeatedly asked for more information and never tired of learning the names of all the plants he could collect. This incident was the first revelation of his genius;

[1] The 200th anniversary of the birth of LINNAEUS is to be celebrated in many places during May, and the BOTANICAL GAZETTE wishes to share in honoring the memory of so notable a botanist. At its request this sketch has been prepared by Mr. THEO. HOLM, whose selection for the task is justified by his high esteem of the man and intimate knowledge of his life and work.—EDS.

and although he was "doomed to become a minister" while still in the cradle, he always remained faithful to his first impulse to become a student of nature.

As he grew older, this first impulse drove him farther and farther; he commenced to collect plants and insects, and in school he was soon dubbed "the little botanist." Some of his teachers, LANNERUS and ROTHMAN, took a special interest in him, and it was at the urgent request of ROTHMAN that his father abandoned the idea of having his son educated for a minister. LINNAEUS was then sent to Lund to study medicine, and there he had the good fortune to meet the famous STOBAEUS, who soon discovered his talent and aided him in every way to prosecute his studies. He showed him the large collections in the museum, which at that time was quite rich in minerals, shells, birds, and dried plants. Young LINNAEUS took a great interest in these collections and especially in the herbarium, and he very soon began to study the local flora, collecting and drying plants and mounting them.

From Lund he went to Upsala, where he knew he would find a larger library, a botanical garden, and more than all he would have an opportunity to attend the lectures of ROBERG and RUDBECK. On his arrival in Upsala (1728), he met CELSIUS, who treated him with the same fatherly benevolence as STOBAEUS. CELSIUS introduced LINNAEUS to RUDBECK, jr., an acquaintance who became of great importance to him. RUDBECK had himself visited Torneaa, Lapmark, and brought home extensive collections of plants, all of which were lost, however, by the great fire of Upsala (1707). While staying in the house of RUDBECK, LINNAEUS often listened to his narratives about this journey, and he soon felt a vivid desire to see that country and study its fauna and flora. Lapmark was at that time a *terra incognita*, and it was not so strange that the Royal Swedish Society accepted the proposition of CELSIUS and RUDBECK to furnish LINNAEUS with the necessary funds for making a journey to that country to make new collections.

LINNAEUS left for Lapmark in the month of May 1732, and, having made numerous excursions throughout the country, he returned to Upsala in the late fall of the same year. To LINNAEUS the journey became of the greatest importance. The arctic-alpine vegetation that prevails there left a deep impression upon him; his views became broadened; and he acquired great experience in field observation, not only in distinguishing species, but also in the geographic distribution of plants and animals. The results of this journey as they appeared in his *Flora Lapponica* laid the foundation of his fame. In the following year LINNAEUS visited the Swedish province

Dalarne, at the request of Baron REUTERHOLM, who wished him to explore that country as he had explored Lapmark.

While thus LINNAEUS had devoted much of his time to the prosecution of his studies in natural history—botany, zoology, and mineralogy—he managed, nevertheless, to finish his course in medicine. It became clear to him, however, that his prospects as a physician in Sweden were not very promising unless he took the degree of Doctor medicinae. It was then that his friend JOHAN BROWALLIUS persuaded him to take this step, while his father-in-law, Dr. JOHAN MORAEUS, offered to pay his expenses. He selected the University of Harderwijk, a small town in Gelderland, Holland, which at that time was frequently visited by Swedish physicians. In the early spring of 1735 LINNAEUS left Sweden and arrived in Amsterdam June 2; thence he proceeded to Harderwijk, and having passed the preliminary examination he presented as his dissertation "Hypothesis nova de febrium intermittentium causa." Having proved his knowledge of medicine, LINNAEUS received the "diploma, golden ring, and silk-hat" June 23, 1735.

LINNAEUS in Lapland costume; from an oil painting by Hoffman in Amsterdam, 1737.

From Harderwijk LINNAEUS went to Amsterdam, where he visited BURMAN, and thence he went to Leyden. His meeting with GRONOVIUS, BOERHAVE, and CLIFFORD of Hartecamp secured him the unusual opportunity of obtaining an excellent position as naturalist, and also the opportunity of seeing the most famous museums and botanical gardens in Europe. It was at the suggestion and expense of CLIFFORD that LINNAEUS visited England and France, and so great was his admiration for LINNAEUS that he tried to persuade him to make Holland his home, but he returned to Sweden in May 1738.

It is really remarkable to note the good fortune that followed LINNAEUS wherever he went, in meeting congenial friends and in gaining their confidence and admiration. His strong personality and his enthusiasm for

natural science impressed everyone with whom he came in contact. His work in Holland resulted not only in the development of the large collections at Hartecamp, but also in the publication of some of his greatest works. Twelve important works were published during the two and a half years spent in Holland among which were the following: *Systema naturae*, *Musa Cliffortiana*, *Bibliotheca botanica*, *Fundamenta botanica*, *Flora Lapponica*, *Critica botanica*, *Hortus Cliffortianus*, *Genera plantarum*, and *Classes plantarum*.

On his return to Sweden, LINNAEUS was appointed surgeon of the admiralty and Regius Botanicus, and a few years afterward he was made Professor ordinarius at the University of Upsala (1741), and became the founder of the Museum Academicum. As a teacher, LINNAEUS showed an indefatigable interest in his pupils; by lectures and excursions in the field he taught them how to study nature, and it was under his patronage that several young men were sent to foreign countries to make collections. In this way, and also through his numerous friends among foreign botanists, LINNAEUS succeeded in accumulating an enormous mass of material for the completion of his work.

His aim to make natural science popular was crowned with success. It is difficult to find a whole series of publications by one man, in which the materials of natural science are brought together and presented so intelligibly as in the works of LINNAEUS. The simplicity that characterized his life was also expressed in his scientific methods. His ability to describe species of animals and plants in a very few words was unexcelled. He was the first to establish a system by which all plants might be readily classified, and although purely artificial this system has proved to be very useful, and is to some extent really a part of what we call now the natural system; and the terminology which he proposed is the one that is followed today.

The credit for having introduced binomial nomenclature as a "general principle" also belongs to LINNAEUS. He was actually the founder of plant morphology and plant geography, which may be seen from the following dissertations: Prolepsis plantarum, Sponsalia plantarum, Gemmae arborum, and from the introductions to his *Flora Lapponica*, *Hortus Upsaliensis*, etc. He studied animals and plants as living organisms, as members of a great living world, and he outlined in a remarkably simple way the distinction that may be observed between species and varieties. His greatest talent consisted in his unique power to grasp nature as a whole and to classify; but to classify in the spirit of LINNAEUS is something more than is understood by classification in modern times. He was com-

pelled to invent a terminology, and to establish rules for describing and naming species as well as genera; and even if the system which he established was purely artificial, he indicated by his "Ordines naturales" that a natural system is the supreme end of systematic work.

LINNAEUS at the age of 67; from a painting by Per Krafft.

To his last days he preserved the friendly and simple nature that had marked him from his youth. Very characteritsic of him was his susceptibility to impressions and his indomitable energy. During the long period of active life he always declined to enter into discussion with those who opposed him; and he was accustomed to say: "If I have erred, nothing will be gained; but if I am right, I shall be so as long as nature exists." He was a very religious man and a firm believer in the inevitable Nemesis.

He died January 10, 1778, and was buried in the old cathedral of Upsala. A beautiful monument was erected on his grave, and the brief inscription shows how much he was appreciated by his friends and pupils. It is as follows:

Carolo a Linné
botanicorum principi.
Amici et discipuli.
MDCCXCVIII.

THE ORGANIZATION OF THE ECOLOGICAL INVESTIGATION OF THE PHYSIOLOGICAL LIFE-HISTORIES OF PLANTS[1]

Upon several occasions I have expressed the belief that the first need of plant ecology is the determination of the physiological life-histories of the forms concerned. I propose now to explain more fully what I mean.

First, it is essential to note our changing conception of ecology. It is not long since we sought a use for every detail of plant structure and habit, and, correlatively, assumed that these had been developed in some kind of causal touch with the environmental conditions they were supposed exactly to fit. This was causal, or historical, adaptation, and it was the logical product of the Darwinian assumption of a struggle for existence so keen as to make even minutiae determinative of the survival or extinction of whole organisms, and through them of entire species. Now, partly because of the work of DE VRIES, but partly, I venture to assert, because of the studies of ecologists themselves, we are ceasing to require utility in details of structure and habit, and are coming to believe that such details may be determined by factors wholly independent of the immediate environment. This newer view does not exclude the possibility of causal or historical adaptation in details, but it accepts the probability of a very different origin and meaning of those details. And this different non-causal origin and meaning of the relation between the details of structure-habit and environment may be either of these two. First, the adaptation may be real but a matter of accident or coincidence, the details arising from internal or other irrelative causes and finding their appropriate environment by a process of sifting. Second, the details, however arisen, may have no positive relationships whatever with the environment, but, not happening to run counter to any very potent feature of that environment, they exist by toleration. In brief, while adaptation as a broad, a general, a generic matter is a reality and rests upon a certain historical or causative basis, adaptation as an exact, a minute, a specific matter is quite different; it may be causative, but it is more often coincidental or tolerative. The ecology of the future will be, primarily, not a search for utilities, but an analysis of meanings.

I emphasize this matter thus fully because I believe that in the phase of ecology of greatest present-day interest, viz., physiognomic ecology, the study of the factors determining the features of vegetation, it will prove most illuminating. A great deal of our supposed adaptation of vegetation

[1] Read before the Botanical Society of America at the New York meeting, December 29, 1906.

to habitat is, I have no doubt, not adaptation in the old sense at all, but is a sifting-in of forms whose characters have been elsewhere and otherwise determined, but which happen to match, either by coincidence or by toleration, with the physical conditions prevailing in that habitat. So far do I consider this true that I think our best working hypothesis in this field is this: any plant stands where it does for the reason that the physical demands made by the structure and habit it happens to possess overlap in some degree the physical conditions prevailing in that place, and the better they match the more nearly does the plant find its optimum, and the worse they match the more slender is the hold of the plant upon that place. Now the study and measurement of the physical factors of environments is steadily progressing; it behooves us to study and measure the physical demands of the plants in order that we may be able to compare the one with the other. This is the crux of what I mean by the need for physiological life-histories of plants.

I come now to the practical part of the subject. I assume that the plant is a bundle of physical needs, and that our aim is to determine what and how great these are. Then these things are needful:

1. We must devise methods and instruments, for the most part autographic, for measuring and recording each physiological process. This, indeed, we are doing, but must do more and better.

2. We must develop a system of standard units for each physiological process, such as will permit their exact expression and their comparison. We already measure photosynthesis in grams per square meter of surface per hour, and are approximating to similar definite units for respiration and transpiration. We must develop similar systems for the other processes. Further, we must develop methods of graphic expression of such data in order that they may be readily matched against the graphic results supplied by study of the environments. In most cases these will doubtless work themselves out in the form of minimum-optimum-maximum curves, but it will not be enough to make these curves represent means or averages; they must express the range of frequency from the mean, which can be done by means of shaded or penumbrate graphs, in which the mean forms the dark center and the shading merges off thence to the extremes.

3. We must not confine our measurements to those invisible processes in the protoplasm which we commonly associate with physiology, but must include structure which is simply an external and visible manifestation of physiological operations, a tool which physiology forges as an aid in its processes. Does a plant produce a long tap-root? That is because, for reason sufficient unto itself even though unknown to us, the protoplasm

of that plant extends itself deep into the ground; the structure is a visible physiological result, and is to be measured and expressed like the other physiological processes.

4. We must especially learn to distinguish and to express to what degree the various physiological processes are plastic to the action of stimuli, and to what extent are limited by heredity.

5. We must classify the physiological processes for study. Ecologically speaking there are four critical periods in the life-cycle of a plant. These are (*a*) the germination of seed or spore, (*b*) the orientation of the seedling whereby the plant gains a grip upon its immediate surroundings, (*c*) the expansion of the adult, and (*d*) flowering and fruiting, or sporification. It is not enough that the plant can match an environment in three of these; it must match in all four. I have no doubt dissemination brings regularly into a certain habitat some plants which can germinate their seeds there, flourish as adults, flower and fruit, but in which the seedling stem and leaves cannot stand the light and heat to which they are exposed, or in which the seedling root cannot reach the permanent water supply, and accordingly that kind of plant cannot exist in that habitat. I think it is some such determinant which brings it to pass that, of all the trees whose seeds are brought upon the Miscou sandplains from the neighboring upland, not one can exist there except the white spruce. I think many peculiarities of ecological distribution are determined by just such single seemingly insignificant causes. But to explain such cases we must know the plants, and must know them throughout their life-cycles; and this is the essence of a knowledge of physiological life-histories.

The particulars of a classification of physiological-ecological processes can be worked out only by experience; but following are some of the more important topics:

A. Germination of the seed:
   Amount of water requisite, least and best, and duration thereof.
   Temperature requisite, minimum, optimum, and maximum, and rate under each.
   Light, whether necessary, injurious, or indifferent.
   Quality of water requisite; how much of salts it may contain.
   Free oxygen requisite, or can it germinate under water?
   Germinates on the surface or needs planting, and why?

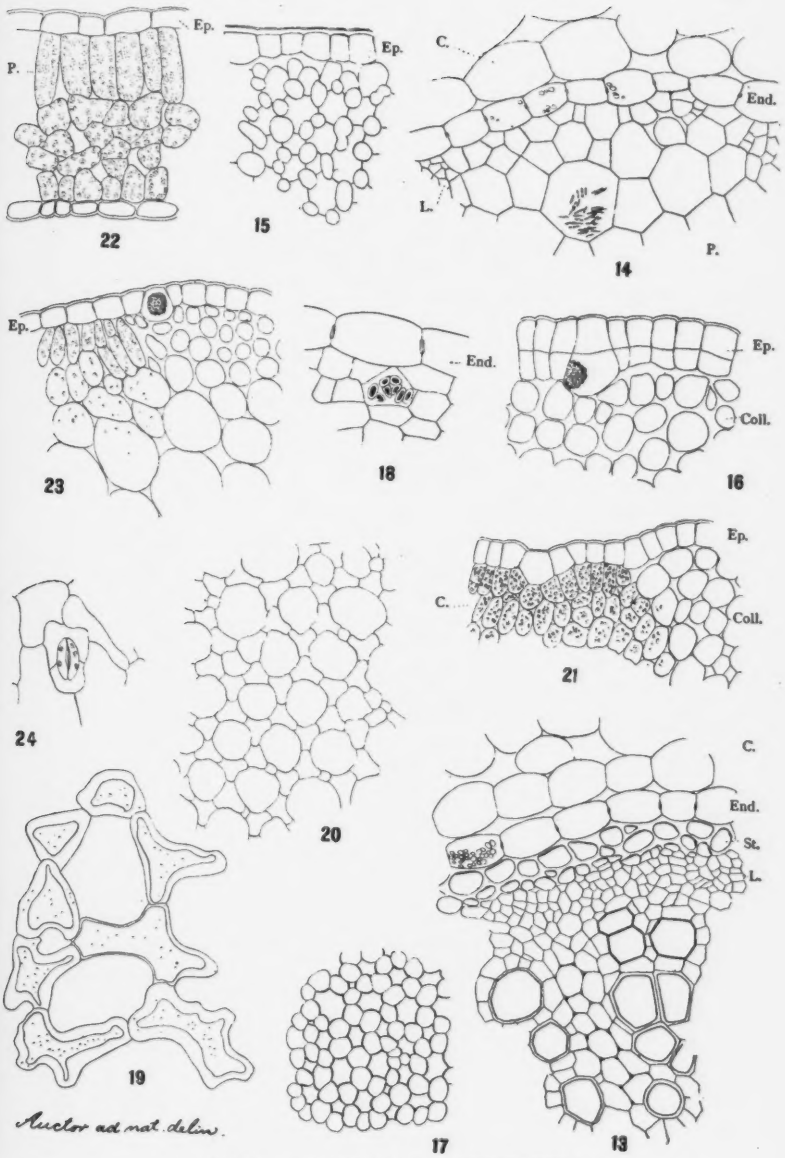
B. The seedling life:
   Root system; ordinary form and size and limits of irritable adjustment.
   Stem and leaf system, ordinary form and size, and limits of irritable adjustment.
   Temperature conditions.

Water, amount and quality requisite.
Light, amount requisite for photosynthetic work, least, best, and most.
How far carried by stored food, and when its own nutrition begins.

C. Adult life:
Demand for water, and interadjustment of absorption, transfer, and transpiration.
Demand for the important minerals.
Dependence upon mycorhiza or other organic aids.
Form and size of vegetative parts, and plasticity thereof.
Temperature demands.
Light demands.

D. Flowering and fruiting (sporification):
Conditions determining beginning of reproduction.
Vegetative powers of reproduction.
Arrangements for uniting the sexes, and extent of dependence thereon.
Duration of vitality, and the resting period of the seed.
Dissemination conditions.

—W. F. GANONG, *Smith College, Northampton, Mass.*



HOLM on RUELLIA and DIANTHERA

CURRENT LITERATURE

MINOR NOTICES

Javanese woods.—Under the direction of Dr. J. W. MOLL, of Groningen, H. H. JANSSONIUS has undertaken to describe in detail the structure of a large collection of the woods of Java,[1] which was made by KOORDERS in connection with his undertaking to prepare for the Buitenzorg Garden a forest flora. KOORDERS marked 4000 individual trees, many of them in the primitive forest, and from these and others collected 15,000 specimens, which form the basis of the work, *Flora arborea javanica*, by KOORDERS and VALETON. The collection of woods comprises 2400 numbers, representing 1070 species, 380 genera, and 80 families. Provision is made for the complete identification of this material with corresponding herbarium material which has been or will be distributed. The descriptive part of this work comprises, under each species, references to the literature (an enormously repetitious method), an account or list of the material, names of the preparations (whether cross, radial, or tangential sections, or macerations), a list of the reagents employed (why not also one of the tools used?), and finally the micrography, including the topography (which is usually illustrated) and a detailed description of the elements. The utmost pains is evident in the attention to every detail of organization and of execution; and if such an enormous accumulation of minutiae is of value to anybody he will certainly find this work a mine of them. It is being issued with the support of the Colonial Office. Professor MOLL desires authors whose work has dealt with the anatomy of woods to send him separates.—C. R. B.

Flora of Columbia, Missouri.—The second number of the science series of "The University of Missouri Studies" is a handsome and bulky volume on the flora of Columbia and vicinity, by F. P. DANIELS.[2] It represents the results of the intensive study of a restricted flora for five or six years, and consists of two parts bearing the titles "Ecology" and "Flora."

Under "Ecology" (pp. 75) "the attempt has been made to indicate the social relationships of the flora; to determine the external factors of these associations; and to ascertain the physiological adaptations of the plants themselves to their environment." The account of plant associations and their distribution, and of the composition of the flora, is to be regarded as a finished one; but the experi-

[1] MOLL, J. W., and H. H. JANSSONIUS, Mikrographie des Holzes der auf Java vorkommenden Baumarten. Erste Lieferung. 8vo. pp. 368. *figs. 44.* Leiden: E. J. Brill. 1906. *M6.*

[2] DANIELS, F. P., The flora of Columbia, Missouri, and vicinity; an ecological and systematic study of a local flora. pp. vi+319. 1907.

mental work necessary to establish the conclusions in reference to factors and adaptations remains to be done.

Under "Flora" (pp. 200), 1058 native and introduced species are enumerated, representing 435 genera and 101 families. Attention is called to the fact that the most striking feature of the flora is the large number of Gramineae, Leguminosae, and Compositae, and the almost complete absence of Coniferae, Orchidaceae, Ericaceae, and Gentianaceae. New species are described under Physocarpus (2) and Vernonia (9), and a synopsis of the latter genus appears in an appendix. Several appendices, an elaborate summary, and a very full index show a real consideration for the convenience of the reader.—J. M. C.

Irritability.—FITTING prepared, at the request of the editor of *Ergebnisse der Physiologie* in 1905 an essay entitled *Das Vorkommen von Reizleitungsvorgängen bei den Pflanzen und die Methoden zu ihrem Nachweise*, and in 1906 for the same work a second, *Der Ablauf der Reizleitungsvorgänge bei den Pflanzen*. These essays are synoptical in their character and include extensive references to the literature of the subject, with the intention that these summaries might be useful to other physiologists as a source of information and to plant physiologists might serve as a starting-point for further investigations. Inasmuch as the work in which they appeared has a rather limited circulation, especially among botanists, it seemed wise to the author to publish the two papers also as an independent physiological monograph; and in this form they do indeed make a small volume,[3] which can be had at a low price and thus becomes readily available. This work puts the facts of the matter succinctly, discusses the theories of conduction critically though briefly, and therefore is likely to serve the very purpose which the author had in mind. The original separate publication has involved the retention of the bibliography in two lists, largely duplicates; but this is a small inconvenience in view of the larger service.—C. R. B.

German south-polar expedition.—Of the sumptuous quarto volumes reporting the results of this expedition in 1901–3, the seventh is devoted to botany. In the the first part, which has just been published,[4] HENNINGS reports upon the Fungi, describing over 30 new species (2 plates); ZAHLBRUCKNER treats the lichens, among which he finds 17 new species and a new genus, *Steinera* (Lichenaceae), and takes occasion to describe more fully a number of little-known species (3 plates); SCHIFFNER lists the liverworts (of which about 40 were previously known), describing 3 new species and a new form out of the 14 collected (1 plate); BROTHERUS found in the collections 61 mosses, of which 14 were new (3 plates); SCHENCK reports upon the vascular plants of each island, but finds no new species.

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[3] FITTING, HANS, Die Reizleitungsvorgänge bei den Pflanzen. Imp. 8vo. pp. xvi+157. *figs. 15*. Wiesbaden: J. F. Bergmann. 1907. *M*3.60.

[4] Deutsche Südpolar-Expedition 1901–1903, im Auftrage des Reichsamtes des Innern, herausgegeben von ERICH VON DRYGALSKI, Leiter der Expedition. VIII Band, Botanik. Heft 1. 4to. pp. 176. *pls. 19. figs. 25*. Berlin: Georg Reimer. 1906. *M*40.

About one-third of the volume is devoted to a discussion by Dr. E. WIRTH of the ecological aspects of the vegetation, and this is illustrated by unusually fine figures and 10 plates (half-tones and photogravures), showing the formations and some individual plants. The annual course of vegetation on Kerguelen is also treated at some length.—C. R. B.

Errera Botanical Institute.—There has come to hand the second volume of papers from this institute, two volumes of which, published earlier, were noticed in this journal recently.[5] This volume[6] contains several papers on nitrates and ammoniacal salts, especially in relation to yeasts and other fungi and to root-tubercles, by LAURENT and by MARCHAL; some brief notes on microscopical and bacteriological technique by ERRERA and DE WEVRE; a considerable number of papers on the occurrence, localization, and significance of alkaloids in plants by ERRERA, CLAUTRIAU, MAISTRIAU, MOLLE, DE WEVRE, DE WILDEMAN and DE DROOG; several papers on proteids by ERRERA, MARCHAL, CLAUTRIAU, and DE WEVRE. All these papers have been published before, dating from 1881 to 1904, but mostly between 1888 and 1895. The volume closes with an annotated bibliography (41 pages) on alkaloids, glucosides, and tannins, etc., brought together by ERRERA and not previously published.—C. R. B.

British vascular plants.—Messrs. JAMES BRITTEN and A. B. RENDLE have compiled a list of British seed-plants and ferns[7] in accordance with the international rules of nomenclature adopted by the Vienna Congress. The list is most timely and will prove a great convenience to students of the British flora. The British systematists are now in a condition of most enviable uniformity as to nomenclature, evidently having taken part in the Vienna Congress in the expectation of abiding by its decisions, and giving up, for the sake of harmony, even so cherished a custom as using the specific name first employed in the genus accepted. If our own flora were not so extensive, and if our own systematists were content to waive individual opinions that did not happen to be accepted by the Congress, such a working-list might be prepared for this country.—J. M. C.

NOTES FOR STUDENTS

Items of taxonomic interest.—L. M. UNDERWOOD (Bull. Torr. Bot. Club **33**: 591–605. 1906) has revised the American species of Stenochlaena, 12 being recognized and 3 new ones described.—W. H. BLANCHARD (Torreya **7**:7, 8. 1907) has described a new Rubus (blackberry) from Mass. and R. I.—A. W. EVANS (Bryologist **10**:24–30. 1907) discusses and approves the reasons assigned by

[5] BOT. GAZETTE **43**:215. 1907.

[6] Recueil de l'Institut Botanique (Université de Bruxelles) publié par L. ERRERA. Tome II. Imp. 8vo. pp. xii+415. *pls.* 4. *figs.* 3. Bruxelles: Henri Lamertin. 1906. *fr.* 20.

[7] List of British seed-plants and ferns. Department of Botany, British Museum (Natural History). pp. 40. Published by the Trustees of the British Museum. 4*d*.

LEVIER for retaining the genera Calypogeia and Gongylanthus as against Kantia and Cincinnulus, gives the synonymy of *C. fissa*, mentions the other N. Am. species, and proposes a new combination (*C. portoricensis*) for a West Indian species.—F. LAMSON-SCRIBNER (Rhodora **9**:17–23. 1907) has presented the eastern species of Muhlenbergia, suggesting a somewhat new classification and segregating several sub-species and one new species.—M. L. FERNALD (*idem* 23–25) has described the alpine Rhinanthus of Quebec and New Hampshire as a new species (*R. oblongifolius*).—W. W. EGGLESTON (Torreya **7**:35, 36. 1907) has described 2 new species of Crataegus, one from Vermont, the other Mexican.—P. A. RYDBERG (Bull. Torr. Bot. Club **34**:35–50. 1907), in his 17th "Studies of the Rocky Mountain flora," has described new species in Pedicularis, Adenostegia, Castilleia (13), Lupinus (10), Trifolium (4), Tium, Hamosa, Xylophacos, and Homalobus (2).—L. DIELS (Bot. Jahrb. **39**:469–486. 1907), in a synopsis of African Anonaceae, describes *Tetrastemma* as a new genus.—A. ENGLER (*idem* 573–580) has published *Sloetiopsis* (Moraceae) and *Pierreodendron* (Simarubaceae) as new African genera.—A. BRAND (Pflanzenreich, part 27. 1907), in a monograph of Polemoniaceae, recognizes 12 genera and 277 species, and describes new species in Cantua (2), Polemonium (3), Phlox (9), Gilia (12), Navarretia (7). and Langloisia.—W. BOTTING HEMSLEY (Annals of Botany **21**:71–77. *pls. 9–10.* 1907) has described a new genus (*Seychellaria*) of Triuridaceae from the Seychelles.—CARDOT and THERIOT (Univ. of California Publications, Bot. **2**:297–308. 1906), in a list of Alaskan mosses collected by W. A. SETCHELL and others in 1889, describe and illustrate new species in Orthotrichum, Bryum (2), and Hypnum.—H. CHRIST (Bull. Herb. Boiss. II. **7**:257–274. 1907), in presenting the ferns of his *Costa Rican Flora*, describes 17 new species; and also (*idem* 275, 276) describes a new fern genus (*Lathyropteris*) from Madagascar, with characters intermediate between those of Pellaea and Pteris.—E. LEMMERMANN (Bot. Jahrb. **38**:343–382. 1907), in an account of the algal flora of the Chatham Islands, describes a new genus (*Dermocarpella*) of Chamaesiphoniaceae.—G. W. WILSON (Bull. Torr. Bot. Club. **34**:61–84. *figs. 10.* 1907), in the first paper of a series entitled "Studies in N. Am. Peronosporales," presents the genus Albugo, gives lists of hosts, recognizes 13 species, and describes one as new.—Miss G. S. BURLINGHAM (*idem* 85–95) has described 6 new species of Lactarius from Vermont.—C. H. PECK (*idem* 97–104) has described 20 new species of fungi, in 18 genera.—J. M. C.

Biometric studies.—FAWCETT[8] has studied the variation in number of ray-flowers in the following Compositae: *Anthemis Cotula* from seven localities, *Achillea Millefolium* from four localities, and *Senecio triangularis*, *Aster adscendens*, and *Erigeron salsuginosus*, each from one locality. The results are not well discussed, but the data are given in tables and also represented by curves which show the following facts of interest: (*a*) Only in the case of Anthemis and Achillea were the numbers sufficient to give dependable results. (*b*) Both of these give

[8] FAWCETT, H. S., Variation in ray flowers of *Anthemis Cotula* and other Composites. Proc. Iowa Acad. Sci. **1905**:55–58. *pls. 12–20.* 1905.

strongly monomodal curves, the former with the mode at 13, the latter with the mode at 5, thus supporting LUDWIG'S view as to the prevalence of the terms of the Fibonacci series as modal numbers in the variation curves for ray-flowers. (*c*) Individual variation is shown in several tables, including about 70 individuals of Anthemis and 40 individuals of Achillea. These show that considerable differences occur, but so far as can be seen each habitat studied shows about the same series of individual variabilities. (*d*) Collections of the same species from different localities show little place-variation except in one instance. The number of rays in the heads of Achillea are only four in a much larger percentage of the heads at Ames, Iowa, than at three other localities from which material was secured. (*e*) Collections of Anthemis in a single habitat near Ames, in August and again in September, show a somewhat higher average number of rays at the time of the earlier collection, in this agreeing with results reached by the reviewer in the genus Aster. The modal number was 13 in both collections. It is stated that greater variability was observed in the ray-flowers of Anthemis growing in rich soil than elsewhere, but the data upon which this statement rests do not appear in the tables.

The number of seeds of the lotus, *Nelumbium luteum*, as it occurred in the western part of Lake Erie in 1902, has been studied statistically by PEARL,[9] who finds that the distribution of the variates gives a good example of the normal curve with the following constants: average 24.874±0.078, standard deviation 4.339±0.055, coefficient of variation 17.445±0.162. A complete analysis of the curve is made and its departures from the theoretical are accounted for as due to random sampling. An interesting numerical relation bearing upon the distribution of fecundity is pointed out. It appears that capsules bearing fewer than the median number of seeds produce only 42.96 per cent. of the total number of seeds, while the remaining 57.04 per cent. are borne by plants which severally produce more than the median number. This fact is conditioned by the normal form of the curve. The maintaining of the normal curve would seem to require either that the inheritance of seed-number is inappreciable or that there is unequal elimination of the seeds coming from large and from small heads.—G. H. SHULL.

Development of the seed of Alsinoideae.—Miss GIBBS,[10] in working over the development and germination of the seed in the subfamily Alsinoideae, of the Caryophyllaceae, has shown that in these features there is a marked uniformity in this group, with evidences of a progressive specialization showing a trend from the Sperguleae to the Alsineae. The latter is indicated especially by an increase in size, and presumably in efficiency as an absorbing organ, of the suspensor; and also by the increased specialization of the inner layer of the outer integument, which is believed to serve as a water jacket in the developing seed. The structure

[9] PEARL, R., Variation in the number of the seeds of lotus. Amer. Nat. **40**:757–768. *figs.* 4. 1906.

[10] GIBBS, L. S., Notes on the development and structure of the seed in the Alsinoideae. Annals of Botany **21**:25–55. *pls.* 5–6. *figs.* 4. 1907.

of the chalazal region of the seed was studied in some detail, and the attempt is made to correlate the structure with the functions of this region in conveying food to the young seed after the cutinization of its coats, and in providing for the necessary gaseous interchange with the seed.

The embryo-sac is developed, without division to tapetum or megaspores, from a hypodermal cell of the ovule. The antipodals are evanescent, and the multinucleate endosperm-sac grows to occupy the whole peripheral region of the campylotropous ovule, and is finally filled by the strongly curved embryo. The endosperm is a single layer of cells throughout, though much thicker in the micropylar cap of endosperm which covers the radicle in the mature seed. This part of the endosperm seems the more important, and evidently serves the part of a digesting and absorbing structure in transferring food material from the nucellus to the embryo during its later intraseminal development and the early stages of germination. This function is indicated by the position of the endosperm, by the nature of its cell contents, and by the fact that seeds from which the endosperm has been removed do not germinate.

This work of Miss GIBBS adds another series of perisperm-containing seeds to those in which JOHNSON[11] and LEWIS[12] have shown that the endosperm is not for the storage of food for the embryo, but serves to digest and pass on to the embryo, before and during germination, the starch stored in nucellar tissue.—DUNCAN S. JOHNSON.

The structure of Trigonocarpus.—SCOTT and MASLEN[13] have been investigating the structure of certain species of Trigonocarpus, a common seed-genus of the British Coal-measures. The species discussed are *T. Parkinsoni*, which name replaces the more familiar *T. olivaeforme*, and *T. Oliveri*, a new species. The general oval form of the winged body of the seed and its very prominent micropylar beak are the familiar features. The testa is distinctly cycadean in character, the outer fleshy and the stony layers being very evident, while there are traces of the inner fleshy layer. The micropylar beak is often as long as the body of the seed, and in some specimens twice as long, and is peculiar in bearing two broad wings, whose real nature is problematical. The nucellus and testa are free throughout, a feature, presumably an ancient one, belonging to certain paleozoic seeds. The vascular system of the seed is in general that described by OLIVER for Stephanospermum, namely, an outer system running in the outer fleshy layer, and an inner system traversing the nucellus. This nucellar system in Trigonocarpus is quite conspicuous, forming a "practically continuous sheath" in the lower part of the nucellus, and traceable through the whole length of the nucellus, almost to the base of the pollen chamber. The pollen chamber is rela-

[11] BOT. GAZETTE **34**:321–340. *pls. 9, 10.* 1902.

[12] BOT. GAZETTE **40**:79. 1905.

[13] SCOTT, D. H., and MASLEN, ARTHUR J., The structure of the paleozoic seeds *Trigonocarpus Parkinsoni* Brongniart and *Trigonocarpus Oliveri*, sp. nov. Part I. Annals of Botany **21**:89–134. *pls. 11–14.* 1907.

tively small and has not been found to contain pollen grains. The megaspore membrane is distinct, but structureless, and no traces of endosperm or archegonia were found.

The second part of the paper will be devoted to a discussion of the general bearing of the investigation and the probable affinities of the seed. It is to be regretted that in such a paper the citation of literature is not more specific. Reference merely to volume numbers puts needless work upon those who wish to consult the literature.—J. M. C.

Dorsiventrality in mosses.—NĚMEC has continued his study of dorsiventrality induced by light, finding additional species[14] in which this character can be altered. The tenacity with which dorsiventrality is retained under changed illumination differs widely. Thus in *Anomodon viticulosus* every flank in turn, as more strongly illuminated, may become the dorsal side. In Neckera and Homalia, on the contrary, only the dorsal and ventral sides could be made to exchange relations. Ageotropic species are usually strongly diaheliotropic (but may become positively clinoheliotropic), turning the dorsal side toward light. Geotropic species are hindered from acquiring a diaheliotropic position, especially if they must curve nearly to the horizontal. The species whose dorsiventrality is not reversible sometimes do not attain completely the diaheliotropic position if much bending is required. Such incomplete reactions are still more common among leafy Jungermanniaceae.

In a later paper on the same lines[15] NĚMEC deals especially with *Fissidens* spp., and *Dicranum scoparium*. In Fissidens the dorsiventrality (morphological as well as physiological) can be abrogated and recalled at will. The stems are also diaheliotropic and geotropic. In *Dicranum scoparium* the lateral curvature of the leaves is a heliotropic response which is induced very early and persists for a considerable time even in darkness, but finally disappears, returning again with one-sided illumination. The complicated interrelations of geotropism and heliotropic dorsiventrality are worked out in detail.—C. R. B.

Galvanotropism of roots.—A paper on this subject, published in September 1904 by Dr. AMOS PLOWMAN,[16] has come to our attention since writing the notice of the papers by SCHELLENBERG and GASSNER.[17] The methods used and the conclusions reached are anticipatory, in large measure, of those of GASSNER. PLOWMAN used carbon electrodes and states the strength of currents used in terms of current density, those mentioned lying mostly between 0.1 and 1.5 milli-

[14] NĚMEC, B., Die Induktion der Dorsiventralität bei einigen Moosen. II. Bull. Int. Acad. Sci. Boheme **11**: (1–7). 1906.

[15] NĚMEC, B., Die Symmetrieverhältnisse und Wachstumsrichtungen einiger Laubmoose. Jahrb. Wiss. **43**:501–579. *figs. 33*. 1906.

[16] PLOWMAN, A., Electrotropism of roots. Am. Jour. Sci. IV. **18**:228–236. *pls. 9, 10*. 1904. Also earlier reports *ibid.* **14**:131. 1902, and **15**: 94–104. 1903.

[17] BOT. GAZETTE **43**:218. 1907.

amperes per cm^2-sec. He finds the positive curvature constant and shows clearly that it is due to injury of the cells on the positive side. He does not find the negative curvature constant in any case, but observes that the positive curvature (which he calls normal) may be produced, even when the negative appears, by varying the strength and time of action of the current. This GASSNER confirmed, but he paid more attention to the negative curvature as the initial effect of very weak currents, and lays stress on it in identifying galvanotropism with traumatropism as an irritable phenomenon.

PLOWMAN ascribes the injury causing positive curvatures to positive electrons bombarding the side of root turned toward the anode (wherefore he prefers *electrotropism*). He specifically denies the influence of products of electrolysis. Negative electrons he finds innocuous and perhaps even stimulative. Thus his facts are mainly corroborated by GASSNER, but the two interpretations are quite different. GASSNER also seems to have entirely overlooked PLOWMAN's papers.—C. R. B.

Morphogenesis in Ceratophyllum.—A recent publication by the Carnegie Institution,[18] under the authorship of Dr. PEARL and assistants, proves to be a contribution of unusual merit because of the masterly way in which the biometrical method has been applied to one of the most important but neglected problems of biology. Two laws of growth in Ceratophyllum have been formulated on the basis of convincing evidence. The first law is: "The mean number of leaves per whorl increases with each successive whorl, and in such a way that not only does the absolute increment in each leaf-number diminish, but also the rate of increase diminishes as the ordinal number of the whorl, measured from a fixed point, increases." The second law is: "As whorls are successively produced by a growing bud, they are formed with ever-increasing constancy to their type, the ultimate limit towards which the process is tending being absolute constancy." The significance of these laws and the field for physiological study suggested by them is far too great to be elaborated here and reference to the original is urged. The paper shows a clear scientific discernment and is a model of composition. It may safely be said that the Carnegie Institution has not wasted any money on this minor grant. The value of such a contribution as compared with its insignificant cost goes far toward compensating for the cost of other small grants which have proved less fruitful.—RAYMOND H. POND.

Relation of saprophytic fungi to the substratum.—Two papers have appeared dealing with the relation of some saprophytic fungi to their substratum. The first of these, by KRATZ,[19] deals with pyrenomycetes growing on dead stems of herbaceous plants and on leaves. It consists mostly of brief categorical descrip-

[18] PEARL, RAYMOND, with the assistance of OLIVE M. PEPPER and FLORENCE J. HAGLE, Variation and differentiation in Ceratophyllum. Pub. Carnegie Institution of Washington no. —. pp. 136. 1907.

[19] KRANTZ, CARL VON, Ueber die Beziehungen der Mycelien einiger saprophytischer Pyrenomyceten zu ihrem Substrat. Hedwigia **46**:1–24. *figs.* 8. 1906.

tions of the fruit-bodies and mycelia of the fungi considered. The author attempts to distinguish form-types of perithecia according to their position on or their relation to the elements of the stem; for example, the perithecia originating under the sclerenchyma sheath are flattened, while those originating under the epidermis are round. That pressure from any cause will influence the form of perithecia is self-evident and of little importance. One general fact to be deduced from the paper is that the sclerenchyma tissue is not penetrated by the fungous hyphae.

The second paper, by DUYSEN,[20] deals with wood-inhabiting discomycetes. In this it is shown that the mycelium of many of these fungi, as Helotium, Coryne, Mollisia, and others, penetrates the cells only by the pits or by cracks and fissures caused by other agencies. Enzyme action here is apparently of less importance in aiding the hyphae to penetrate cell walls. In others, like Propolis and Schizoxylon, more or less of the wood is actually destroyed by enzymosis, mostly in the vicinity of the fruit-body. The sclerenchymatous tissue is not injured.—H. HASSELBRING.

A study in endemism.—Mount Ritigala is an isolated mountain in north-central Ceylon, within 100 feet of whose summit there occurs a remarkable flora, covering only a few acres. In this small space there exist species that belong to the flora of the wetter districts of Ceylon, a regular oasis of vegetation distinct from the dry country surrounding it. WILLIS[21] has studied the possibilities of the origin of this isolated flora and its endemic forms. The number of species enumerated is 144, but 41 of these are eliminated as occurring also in the dry zone and so are not compelled to travel 40 miles to reach the summit. The 103 remaining species all belong to the moist region of Ceylon, at least 40 miles away. Of these species, 24 can be carried by birds, 49 by the wind, and the distribution methods of the remaining 30 are doubtful. After various analyses of the statistics, the conclusion is reached "that endemism, other things being equal, goes in general with difficulty of distribution, and with rare arrival in one spot." For example, the bird-carried forms arrive more regularly than the others, and there is one endemic form among the 24 species; the wind-carried forms arrive less regularly, and there are three endemic forms among the 49 species; while the plants whose method of distribution is called "doubtful" arrive most rarely, and there are 8 endemic forms out of 24 species, 6 of the 30 species being rejected for a special reason.—J. M. C.

Motor mechanism of Berberis stamens.—JUEL[22] has made some interesting observations and experiments on the staminal filaments of Berberis and Cen-

[20] DUYSEN, FRANZ VON, Ueber die Beziehungen der Mycelien einiger, hauptsächlich holzbewohnender, Discomyceten zu ihrem Substrat. Hedwigia **46**:25–56: *figs.* 7. 1906.

[21] WILLIS, J. C., The flora of Ritigala, an isolated mountain in the north-central province of Ceylon; a study in endemism. Annals Roy. Bot. Gard. Peradeniya **3**:271–302. 1906.

[22] JUEL, H. O., Einige Beobachtungen an reizbaren Staubfäden. Bot. Stud. tillägn. F. R. KJELLMAN 1–20. l. 1. Upsala. 1906.

taurea, though he has not approached nearer a final explanation of the phenomenon than others before him. A cross-section of the filament shows a dorsal region of collenchyma-like tissue with almost imperceptible intercellular spaces. The ventral region is occupied with loose parenchyma. The walls of the collenchyma-like tissue are characterized by considerable contractility in longitudinal direction. The papillose epidermis of the ventral side is practically impermeable, but if carefully removed and the exposed tissue submerged in solutions of varying osmotic strength it appears that a curvature of the filament results from the plasmolysis and consequent contraction of the collenchyma-like tissue. The author's explanation agrees with that of PFEFFER, namely, filtration under turgor pressure, and whatever causes the escape of water from the cell permits contraction of the cell walls and results in curvature. The author thinks that the papillose epidermis of the ventral side cooperates with the collenchyma-like tissue in contraction. Why the contact stimulus should cause filtration under pressure is no more accounted for than before. The filaments of Centaurea will endure surprising transpiration without loss of contractile capacity.—RAYMOND H. POND.

The fertile spike of Ophioglossaceae.—CAMPBELL[23] has studied the morphology of the sporophyll and the distribution of the vascular bundles in the three genera of Ophioglossaceae, abundant material having been obtained during his recent visit to the oriental tropics. A study of the development of the sporophyll suggested that the "fertile spike" is the terminal structure rather than an adaxial branch. This view was confirmed by the distribution of the vascular bundles of the leaf, those supplying the spike evidently not being given off from the main bundles of the petiole as branches, but being a continuation of the main bundles. From this point of view, the fertile spike terminates the main axis, which bears the foliage blade as a lateral member. This accords with the author's previously expressed view that Ophioglossum is perhaps the most primitive of the pteridophytes, the "fertile spike" being most naturally connected with such a structure as the sporogonium of Anthoceros. "This hypothesis assumes that, by the development of a root from the lower part of the sporophyte and a complete septation of the sporogenous tissue of the sporogonium, so that something resembling the spike of an Ophioglossum resulted, there would be formed a plant not very unlike *O. simplex*."—J. M. C.

A cotton fungus.—According to a preliminary paper by BALL,[24] the "soreshin fungus" which occurs on cotton and other plants in the United States is also very common on cotton seedlings in all parts of Egypt. The fungus is said to be responsible for most of the resowing which is necessary in Egpytian cotton fields. The damage, which is not great, is caused partly by rotting of the seed-

[23] CAMPBELL, D. H., Studies on the Ophioglossaceae. Amer. Nat. 41:139–159. *figs.* 17. 1907.

[24] BALL, W. L., The physiology of a simple parasite. Reprint, Jahrb. Khedivial Soc. pp. 25. *pls.* 6–7. 1906.

ling in the soil and partly by damping off. A large proportion of the plants which are attacked after breaking through the ground recover by subsequent healing of the injured shins. After showing that the fungus is dependent upon oxygen for growth, the writer states his belief that the fungus attacks the plants at the surface of the ground because here only there exists a zone with sufficient oxygen and yet not too dry for the growth.

It may be mentioned that the sore-shin fungus of the United States is believed by DUGGAR and STEWART[25] to be Rhizoctonia. BALL, however, failed to find the typical sclerotia of this genus in the Egyptian form, so that it is possible that the two forms are not identical, unless the sclerotia have been been overlooked.—H. HASSELBRING.

Electroculture.—GASSNER, before he was called to the University of Montevideo, had begun some investigations on the effect of electric currents, constant and alternating, which, though incomplete, had some interesting results.[26] The constant current in general proved injurious (*cf.* his results and PLOWMAN'S on galvanotropism noted in this journal). The alternating current, when the alternations were rapid enough, was not injurious because it did not act at all; it was not found advantageous, as LÖWENHERZ reports.[27] It does kill grubs and worms in the soil when not hurtful to plants and may thus be useful practically. With induced currents from a frictional machine, potted barley grew better when electrified for 13–14 hours daily from needle-points above the plants, which accords with the earlier results of LEMSTRÖM (1890) and CHODAT (1892). One notable fact was the threefold evaporation from the electrified plants, as compared with the controls. Even greater differences, 6:1, appeared when porcelain dishes filled with water were substituted for the pots.—C. R. B.

Palisade cells.—RAUNKIAER decides in favor of STAHL'S view, that palisade cells owe their form to light, as against ARESCHOUG'S that transpiration is the determining cause, from his studies upon the palisade of *Scirpus lacustris*.[28] The leaves of plants growing somewhat apart from the clump show equally well-developed palisade cells in the leaf above water and to a depth of 20^{cm}. From this point to a depth of 50^{cm} the length of the palisade cells gradually diminishes. In similar plants growing crowded and therefore shaded, no palisade cells are distinguishable in the submerged parts, nor in the aerial region up to a height of 30–40^{cm}, where they commence to appear. In this case there is clear evidence that the external factor, light, calls forth this differentiation. In other

[25] The sterile fungus Rhizoctonia. Cornell Univ. Agr. Exp. Sta. and N. Y. Agr. Exp. Sta. Bull. 186. 1901.

[26] GASSNER, G., Zur Frage der Elektrokultur. Ber. Deutsch. Bot. Gesells. **25**:26–38. 1907.

[27] LÖWENHERZ, Versuche über Elektrokultur. Zeit. Pfl.-krankh. **15**:137 ff. 1905.

[28] RAUNKIÆR, C., Nogle Iagttagelser og Forsøg over Aarsagerne til Palissadecellernes Form og Stilling. (Sur les causes qui déterminent la forme at l'orientation des cellules palissades.) Bot. Tidsskrift **27**:293–311. 1906.

plants it my have become hereditary, i. e., due to internal causes. RAUNKIAER finds in certain plants also that direction of light determines the orientation of the palisade cells; in the great majority, however, their orientation is established independent of this factor.—C. R. B.

Inheritance and gynodioecism.—CORRENS[29] makes a third report on the inheritance of sex in gynodioecious plants, the species dealt with being *Satureia hortensis* and *Silene inflata*, previously reported on, and in addition, *Silene dichotoma* and *Plantago lanceolata*. All of these species confirm the two laws previously derived by the author, namely, that in gynodioecious plants each sex-form produces gametes which have the tendency to produce the same sex-form, and that the phylogenetically newer unisexual form dominates more or less completely the older bisexual form. There seems to be a third class in the case of *Plantago lanceolata*, characterized by an intermediate condition. These are described as gynomonoecious or as stunted bisexual. The offspring of these contained 28–32 per cent. ♀, as compared with 0–3 per cent. among the offspring of normal bisexual parents, and 71–96 per cent. among the progeny of fully pistillate individuals.—G. H. SHULL.

Commercial forage seeds.—The adulteration of commercial forage seeds has become a question of great importance in the western agricultural regions, and reliable, easily applied distinctions between the adulterants and the genuine seed are being sought for energetically at the Agricultural Experiment Stations. Two recent bulletins from Kansas deal with two of the most important forage crops, namely alfalfa[30] and blue grass.[31] To recognize without fail the commercial seed of alfalfa is to protect one of the largest financial interests of the region. In the case of the distinction between the grains of *Poa pratensis* and *Poa compressa*, it is interesting to note that these observers have discovered what seems to be an unfailing character in the toothing of the palet, which agrostologists have overlooked.—J. M. C.

Progress of accretion during growth.—As stated by HEDLUND,[32] it is important to ascertain the amount or rather the rate of accretion correlated with internal processes of the protoplasm during growth. This author has made a quantitative study which is certainly a step in advance. He finds that a single cell (alga) grows more rapidly when free than when in contact with a neighbor. Growth declines for a period before division and remains slow while the protoplasm is

[29] CORRENS, C., Die Vererbung der Geschlechtsformen bei den gynodiöcischen Pflanzen. Ber. Deutsch. Bot. Gesells. **24**:459–474. 1906.

[30] ROBERTS, H. F., and FREEMAN, G. F., Alfalfa seed; its adulterants, substitutes, and impurities, and their detection. Kans. Agric. Coll. Bull. 133. 1906.

[31] ———, Commercial seeds of brome grass and of English and Kentucky blue grasses; adulterants and substitutes and their detection. Kans. Agric. Coll. Bull. 141. 1907.

[32] HEDLUND, T., Ueber den Zuwachsverlauf bei kugeligen Algen während des Wachstums. Bot. Stud. tillägn. F. R. KJELLMAN 35–54. *pls. 4*. Upsala, 1906.

engaged in division. The figures support what the author regards as a general law, that the rate of accretion varies inversely with the size of the organism. There is nothing particularly new about that, but there is value in abundant data.—RAYMOND H. POND.

Mechanics of plants.—LORCH describes the arrangement of mechanical tissues in a number of mosses and the warping effects produced thereby in absorbing or losing water.[33] His observations upon the circinate inrolling of *Leptodon Smithii* and some allies, and the behavior of leaves possessing mechanical tissues in ribs and borders, as the Polytrichaceae, are interesting, but develop nothing specially novel. The same may be said of the study of the mechanical system of the hyaline cells in Sphagnum leaves.[34]—C. R. B.

Respiration.—A rather startling announcement is that by STOKLASA[35] and his assistants that in coal and lignite they find an enzyme, peroxidase; and by comparative experiments on sterilized and non-sterilized coals, following the methods of PALLADIN and his pupils, they recognize the excretion of CO_2 as dependent partly upon autoxidation and partly upon enzymic action. The excretion of methane and hydrogen is due to the peroxidase.—C. R. B.

Secretions of enzymes.—PANTANELLI has continued his study of this topic, of which he presents a detailed account.[36] Though he has recorded the effect of many substances upon the formation and action of invertase in Mucor, he has not been able to throw much light upon the deeper problem of the method of secretion.—C. R. B.

Physiology of movement.—The *New Phytologist* is printing an interesting series of lectures on this subject by Mr. FRANCIS DARWIN, beginning in the number for November 1906.[37]—C. R. B.

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[33] LORCH, WM., Einige Bewegungs- und Schrumfungserscheinungen an den Achsen und Blättern mehrerer Laubmoose als Folge des Verlustes von Wasser. Flora **97**:76–95. *figs. 20.* 1907.

[34] ———, Das mechanische System der Blätter, insbesondere der Stämmchenblätter von Sphagnum. *Idem* **97**:96–106. *figs. 11.*

[35] STOKLASA, J., A. ERNST and K. CHOCENSKÝ, Ueber die anaërobe Atmung der Samenpflanzen und die Isolierung der Atmungsenzyme. II. Ber. Deutsch. Bot. Gesells. **25**:38–42. 1907.

[36] PANTANELLI, E., Meccanismo di secrezione degli enzimi. Annali di Bot. **5**:229–272, 355–416, 1906.

[37] I. Associated stimuli. Nov. 1906. II. On some questions of nomenclature and method. Dec. 1906. III. The analysis of geotropism. Jan. 1907. IV. The localisation of perception. Feb. 1907.

NEWS

DR. EDWARD C. JEFFREY, Harvard University, has been promoted to a full professorship of plant morphology.

DR. K. M. WIEGAND, Cornell University, has been appointed associate professor of botany in Wellesley College.

PROFESSOR FRANCIS E. LLOYD, of the Desert Laboratory, is announced for a course in botany during next July at the summer school of Harvard University.

THE MACMILLAN COMPANY has announced the publication of a "Practical text-book of plant pathology" by D. T. MACDOUGAL, F. S. EARLE, and H. H. RICHARDS.

DR. K. MIYAKE, Doshisha College, Japan, has been selected to fill the position of Professor IKENO at the University of Tokyo during the two years' absence of the latter.

THE LAKE LABORATORY of the Ohio State University is located on Cedar Point, near Sandusky, and will hold the session of 1907 from June 24 to August 2. MALCOLM E. STICKNEY, Denison University, will be in charge of the botany.

DR. MEL. T. COOK has been appointed plant pathologist to the Delaware Agricultural Experiment Station, under the recent Adams Act. He is also to act as professor of botany in Delaware College. His future address will be Newark, Del.

DR. JACOB SCHNECK, Mount Carmel, Ill., died December 18, 1906. Dr. Schneck was an old and well-known student of the flora of his region, and his name is a very familiar one to systematists. A number of his contributions appear in the earlier volumes of the BOTANICAL GAZETTE.

THE SEVENTH ANNUAL SEASON of the Minnesota Seaside Station, on the Straits of Fuca, Vancouver Island, is announced for the six weeks beginning about July 6. Full information may be obtained from Assistant Professor JOSEPHINE E. TILDEN, University of Minnesota, Minneapolis.

PROFESSOR W. A. KELLERMAN, Ohio State University, has returned from an absence of three months in Guatemala, where he has been collecting parasitic fungi. He has planned a "Peripatetic School of Tropical Botany" for a limited number of students, the first session to begin December 20, 1907.

SIR THOMAS HANBURY, the owner of the well-known Botanical Garden of La Mortola, Ventimiglia, Italy, died March 9, after an illness of a few weeks. He would have completed his seventy-fifth year on June 21. His death will be deeply mourned by many botanists who have visited his beautiful garden, and who have known him personally.

THE MARINE BIOLOGICAL Laboratory, Woods Hole, Mass., will begin its twentieth session on June 1, 1907. Dr. GEORGE T. MOORE will be in charge of the botany, and associated with him there will be GEORGE R. LYMAN, Dartmouth College, and IVEY FOREMAN LEWIS, Johns Hopkins University. DR. BRADLEY M. DAVIS has resigned.

DR. OTIS W. CALDWELL, State Normal School, Charleston, Ill., has been added to the botanical staff of the University of Chicago, as associate professor of botany in the College of Education, and DR. CHARLES J. CHAMBERLAIN and DR. HENRY C. COWLES have been promoted from instructorships to assistant professorships in the department of botany.

AT THE NEW YORK MEETING of the American Association a silver loving-cup was presented to Professor W. F. GANONG. The presentation was made by Professor G. F. ATKINSON on the part of the former members of the Society for Plant Morphology and Physiology, as a token of appreciation of Professor GANONG'S very efficient services during ten years as executive officer of that society.

THE BIOLOGICAL LABORATORY of the Brooklyn Institute, which conducts summer work at Cold Spring Harbor, has announced that its next annual session will be held during July and August, 1907. The botanical staff will be as follows: Dr. D. S. JOHNSON, Cryptogamic Botany; Dr. E. N. TRANSEAU, Plant Ecology; Mr. H. H. YORK, Associate in Botany; Mr. W. S. COOPER, Assistant in Ecology.

PROFESSOR B. E. FERNOW, State College, Pennsylvania, has been appointed dean of the Faculty of Forestry at the University of Toronto. According to *Science*, "it is proposed to organize the most complete system of forestry education on this continent, the university undergoing now a reorganization and broadening out its policy generally. It is expected that a large forest reservation will be set aside for the use of the school, and university extension work of the broadest kind is contemplated."

DR. OTIS W. CALDWELL, State Normal School, Charleston, Ill., has made several visits to Cuba in search of Microcycas, reported as being endemic on the island and unknown in collections in any reliable way. The last trip was made during February and early March, and resulted in complete success. He has secured material for a proper morphological study of the genus, and his results will be an important contribution to our accumulating knowledge of the morphology of the cycads.

AN ASSOCIATION of twelve botanists has undertaken the direction of the *Plant World*, beginning with 1907. The scope of the journal will be enlarged by including more notes and news, accounts of explorations, illustrations of experiments, discussions of evolution and plant-breeding, etc. The subscription price is to remain $1 a year, and F. E. LLOYD continues to be the managing editor. The association includes the following botanists: J. C. ARTHUR, Miss M. M. BRACK-

ETT, N. L. BRITTON, W. A. CANNON, W. F. GANONG, D. S. JOHNSON, B. E. LIVINGSTON, F. E. LLOYD, D. T. MACDOUGAL, W. B. MACCALLUM, V. M. SPALDING, and J. J. THORNBER.

THE THIRD annual meeting of the Botanists of the Central States was held at Madison, Wis., March 28–30, in connection with the annual meeting of the Central Section of the American Society of Naturalists. About thirty were in attendance and the programme of papers continued until noon of the third day. The dominant note of the programme was cytology. Thursday afternoon was devoted to demonstrations of microscopic material, apparatus, cultures, etc., of which there was an instructive display. A smoker and the annual dinner of the naturalists gave opportunity for social acquaintance. President NEWCOMBE'S address, "A need of botanical science in America," was devoted to showing the need of additional means for the publication of research. The Botanical Society of America was requested by resolution to take up the matter. Professor T. H. MACBRIDE, University of Iowa, was elected president.